Popular Astronomy

Vol. XLVII, No. 7 AUGUST-SEPTEMBER, 1939 Whole No. 467

The First of the Sciences*

By ARTHUR H. COMPTON

We are here to dedicate a great new tool to the better understanding of nature. The building of this great telescope and observatory, no less than the devotion of the lives of the men who are to use them, represents a great venture of faith in the value of truth. Above all other fields of experimental knowledge, the First of the Sciences represents man's effort to achieve a greater manhood by broadening his horizons.

Yet is it really justifiable for able men to devote their energies to solving mysteries remote from daily life, when about us we see civilization shaking and crumbling under violent attacks? The very truths that science has discovered with such hope are being used toward man's destruction. The urgent call comes to every man to do his part in the defense of the precious strength and freedom that has been won. In an age of specialization and scientific techniques, strength lies with that group in which there is the best coöperation in using the tools of science. If one nation elects to bend its great technical and scientific strength toward enhancing its military might, can any neighboring nation safely refrain from using its best efforts in developing its defenses?

Here is a pressing problem which in these difficult days no responsible man of science can escape. It is, I dare say, present in the background of the thinking of all in this assembly.

It is perhaps in the totalitarian states that we find the most extreme expression of the view that all of the energies of a citizen should be spent toward enhancing the welfare of the state. If the state's leaders decide that this welfare requires industrial strength or military might, the diversion of men's efforts from these objectives is a sin against the state.

In astronomy, we find a leading exponent of the alternative view, that if man will find life worth living, he must reach out through a better understanding of the world toward a vision that will give him an objective for life. Here is the sharp distinction between the material and the spiritual aspects of life. If heroic achievement in astronomy is justifiable, it is only through its value in stimulating the growth of the soul of man.

Contrast of Greek and Modern Science

It is customary to date the dawn of science by the successful prediction of an eclipse by Thales of Miletus in the year 585 B.C., twenty-five

*Address given at the dedication of the McDonald Observatory, Mt. Locke, Texas, May 5, 1939.

hundred years ago. Actually, this prediction was made possible by data collected systematically over many earlier centuries by the Babylonians, Chaldeans, and Egyptians. It is true that Breasted has unearthed yet earlier systematic studies of anatomy among the Egyptians; but in view of the early recognition of predictability and law in the motions of the stars, no one will, I believe, dispute the claim of astronomy to the title of "the first of the sciences."

This title is especially significant in that modern astronomy preserves to an unusual degree the spirit of this early science. Science to the Greek meant "the inquiry into the nature of things." It was their hope that this inquiry would lead to finding a better way of life. It is notable that early Greek science up to the time of Aristotle had no relation whatever to mechanical invention. Later, in hands of Archimedes and Hero we do find such applications; but these are distinctly out of line with the trend of scientific thought. As Macauley has pointed out,

> "Once indeed Posidonius, a distinguished writer of the age of Cicero and Caesar, so far forgot himself as to enumerate, among the humbler blessings which mankind owed to philosophy, the discovery of the principle of the arch and the introduction of the use of metals. Seneca vehemently disclaims these insulting compliments. Philosophy, according to him, has nothing to do with teaching men to rear arched roofs over their heads. The true philosopher does not care whether he has an arched roof or any roof. Philosophy has nothing to do with teaching men the use of metals. She teaches us to be independent of all material substances, of all mechanical contrivances."

Let me support this view expressed by Macauley with a quotation from Lucretius, who, if any of the ancients, in his discourse on "The Nature of Things" approaches the modern interests of science.

> "If a man would order his life by a true principle, for him a frugal existence joined to a contented mind will be great riches. For he whose needs are small will never be in want. But men desired to be famous and powerful, hoping that their fortunes might rest on a firm foundation, and wealth might enable them to live a tranquil life. But all in vain . . .
>
> "Man labors to no purpose, and wastes his life in fruitless cares, because he has not learned the true end of possession, and up to what point true pleasure goes on increasing. This by slow degrees has carried life out into the deep sea, and stirred up from their lowest depths the mighty billows of war."

Contrast this with Francis Bacon's attitude, as expressing the interests of modern science. In his "The New Atlantis" he has "The Good Jew" say,

> "The end of our Society is the knowledge of causes, and the secret motions of things, and the enlarging of the bounds of human empire to the effecting of all things possible."

Bacon, in common with most exponents of modern science, saw the chief reason for the promotion of scientific investigation the "fruit" of science in multiplying human enjoyments and the mitigating of human suffering. Thus the director of one of our leading technological institutions takes justifiable pride in noting that during the past half century

the scientific study of mechanics, heat, light, and electricity has led to greater improvement in the economic, social, and intellectual life of man than has any other agency in a comparable period of time.

If along with these undoubted improvements in man's lot has come the use of the powers of science toward man's destruction, it is just as unfair to blame the scientist for this misuse as it would be to blame Prometheus for giving men the fire with which they might not only warm themselves, but burn each others' fields and houses.

We have here at MacDonald Observatory the highest refinement of man's optical technique, a great telescope, equipped with the most carefully devised instruments for examining stars and nebulae with greater detail. We shall learn more about our universe and our relation to it. Yet precisely the same technique and refinement of instruments are being used for the construction of military glasses and range-finders to make possible the firing of guns with more deadly aim.

This contrast of idealistic and sinister uses is as old as modern science. You will recall Galileo's scene with the Venetian Fathers. Here it is as told by Alfred Noyes:

> "He made his telescope; and O, how vividly that day comes back,
> When in their gorgeous robes the Senate stood
> Beside him on that high Venetian tower,
> Scanning the bare blue sea that showed no speck
> Of sail. Then, one by one, he bade them look;
> And one by one they gasped, "a miracle."
> Brown sails and red, a fleet of fishing boats,
> See how the bright foam bursts round their bows!
> See how the bare-legged sailors walk the decks!
> Then, quickly looking up, as if to catch
> The vision, ere it tricked them, all they saw
> Was empty sea again.
>
> Many believed
> That all was trickery, but he bade them note
> The colors of the boats, and count their sails.
> Then, in a little while, the naked eye
> Saw on the sky-line certain specks that grew,
> Took form and colour; and within an hour
> Their magic fleet came foaming into port.
> Whereat old senators, wagging their white beards,
> And plucking at golden chains with stiff old claws
> Too feeble for the sword-hilt, squeaked at once;
> 'This glass will give us great advantages
> In time of War.'
>
> War, war, O God of love,
> Even amidst their wonder at Thy world,
> Dazed with new beauty, gifted with new powers,
> These old men dreamed of blood. This was the thought
> To which all else must pander, if he hoped
> Even for one hour to see those dull eyes blaze
> At his discoveries. . . .
>
> War was the dream
> That filmed those old men's eyes. They did not hear
> My father, when he hinted at his hope
> Of opening up the heavens for mankind
> With that new power of bringing far things near."

We would not deny the enduring value of both contributions of science, the philosophical and the practical, to the life of man. It is, as Professor Sarton has pointed out, in the continued advance of science that we see working the thread of human evolution, man's growth in power and wisdom. He would be blind who could not see the vital need to use all the powers at our command to defend the precious freedom that we have won.

Yet does it not remain true that the values of life are not revealed by technology? We must go far back in history to find a time when men felt lost as they do today. The anchor of religion has been dropped by great groups of men, and has been found to drag in the storm by many others who have held to it for security. I do not mean to imply that religion has nothing to offer; on the contrary, it seems to me that when rightly interpreted we have in religion our greatest hope of reaching a stable and satisfying life. Religion needs, however, the discipline of thought supplied by science to fit the modern needs. In this age, as men throughout the world are trying to formulate a philosophy by which they can live, it is to science that they are turning with confidence in its truth. They ask, can science point the way? It is the same appeal that led the Greeks to search for the nature of things.

Perhaps the man of science feels all too keenly his inability to find anything which gives life dignity and worth. But he can at least aid in satisfying the hunger to understand this mysterious universe and our relation to it. More than ever we feel the need for orientation. And how can this be gained without learning the facts about our world, and calmly and dispassionately considering their implications? It is in just this direction that the first of the sciences continues to make its great contribution. In these difficult times we need to spread widely that veracity of thought that springs alone from the search of truth.

As a representative on this platform of the sister science of physics at the University of Chicago, may I express our congratulations and pleasure at the completion of this great observatory. We share with you the hope for its high achievement. First exponents of exact measurement, in the clocking of the stars, we learned from astronomy the value of precise knowledge. This is, in fact, the distinctive spirit of our science, learned from yours.

Let me leave with you then the description of the spirit of measurement as it has been given by our University's poet, E. H. Lewis, in his "Ballad of Ryerson":

> When from the plunging planet he spread out a hand to feel
> How fast the ether drifted back through flesh or stone or steel,
> The fine fiducial fingers felt no ethereal breath.
> They penciled the night in a cross of light and found it still as death.
> Have the stars conspired against him? Do measurements only seem?
> Are time and space but shadows enmeshed in a private dream?

But dreaming or not, he measured. He made him a rainbow bar,
And first he measured the measures of man, and then he measured a star.
Now tell us how long is the metre, lest fire should steal it away?
Ye shall fashion it new, immortal, of the crimson cadmium ray.
Now tell us how big is Antares, a spear-point in the night?
Four hundred million miles across a single point of light.

Now this is the law of Ryerson and this is the price of peace—
That men shall learn to measure or ever their strife shall cease.
They shall measure the cost of killing, and measure the hearts that bleed,
And measure the earth for sowing, and measure the sowing of seed.
For if they slay the dreamers and the riches the dreamers gave,
They shall get them back to the benches and be as the galley slaves.

But if they be wise to measure the star beneath their feet,
Intense with tissue of power and woven with waiting heat,
There are starry uses of stars. Let them love their planet and see
How it longeth to bear the burden and let the slave go free.
They shall loose the lightning gently, the granite shall bloom with grain,
And under the rainbow glory young Eden shall come again.

Note on a Supposed Earlier Maximum of Nova T Coronae 1866

By DEAN B. McLAUGHLIN

The distinct increase of light of T Coronae Borealis in 1938, with its accompanying spectral changes[1], suggests the possibility that it may be a repeating nova like RS Ophiuchi or T Pyxidis. Formerly another ground for such suspicion lay in the apparent range of magnitude which was smaller than that of typical novae. The recognition that the class M star, formerly regarded as the minimum state of the nova, is probably an unresolved companion[2] makes the range closer to the typical figure. Nevertheless, the fact that there were bright lines in the spectrum in 1921,[3] and that they later disappeared,[4] indicates that the minimum magnitude of the nova is not very much fainter than its companion. The recent brightening cannot be considered a *true recurrence*; possibly it is simply an incident in the post-nova fluctuations which have characterized several novae. But the range from maximum to minimum was probably below the average, and its rate of fading was extremely rapid, like that of RS Ophiuchi, leading to the suspicion that it might recur. In any event this old nova will bear watching.

It is interesting to note that soon after the outburst in 1866 Sir John

[1] Hachenberg and Wellmann, *Zeits. f. Astroph.*, **17**, 246, 1939.
[2] Humason, *Astroph. Jour.*, **88**, 234, 1938.
[3] Adams and Joy, *Publ. A. S. P.*, **33**, 263, 1921; Lundmark, *Ibid.*, 271.
[4] Berman, *Ibid.*, **44**, 318, 1932.

Herschel[5] reported an observation which he supposed might represent an earlier appearance of the nova. On June 9, 1842, while making estimates of magnitude of all visible stars in that region, he noted a star somewhat fainter than sixth magnitude close to the place where the nova later appeared. A chart was reproduced, showing the position in which he observed the star, as well as the accurate position of the nova. He referred also to a celestial globe by Bardin, of epoch 1800, on which a star designated as 9th magnitude was recorded in the same place as his star.

On seeing this note and examining the chart, the author was struck by the large difference of position of Herschel's star and the nova. The separation is fully a degree, and it does not seem possible that so reputable an observer would make such a gross error of position, even by eye estimation, when there were comparison stars as close by as they are in that field. Examination of the Bonn Durchmusterung chart shows a rather bright star, B.D.+25°3020, very close to the place of Herschel's star. The magnitude given in the Henry Draper Catalogue is 7.06, and the spectral class is G0. There are several neighboring stars of the 9th magnitude, but none which would combine with the 7th magnitude object to increase its light by half a magnitude or so. The variable SX Herculis is a full degree away, and it does not seem likely that it would have had any effect even at maximum.

Now the idea that stars fainter than about the sixth magnitude are invisible to the naked eye is a widespread astronomical superstition. Under the most favorable conditions some people have seen stars as faint as the 7th magnitude. The moon was new on June 8, the day before Herschel's observation, so that it had no effect. At that time of year there must have been a very faint twilight in the north, even at midnight, but its effect as far south as Corona would have been negligible,—indeed, in the very feeble glow, a *yellow* star might be seen even more easily than in a very dark sky! In any event, given an unusually clear sky and one which was darker than any English sky of recent years (what with the increased light from cities), it appears distinctly possible that Herschel saw this supposed telescopic star, and that the recorded object on Bardin's celestial globe was another observation of the same one. This is far easier to believe than an identical error of one degree on the part of both Herschel and Bardin.

It seems to the writer that we must reject this supposed case of recurrence of a bright nova and remain content with the present list of three: RS Ophiuchi, T Pyxidis, and Nova Sagittarii 1919, which had an earlier maximum in 1901.

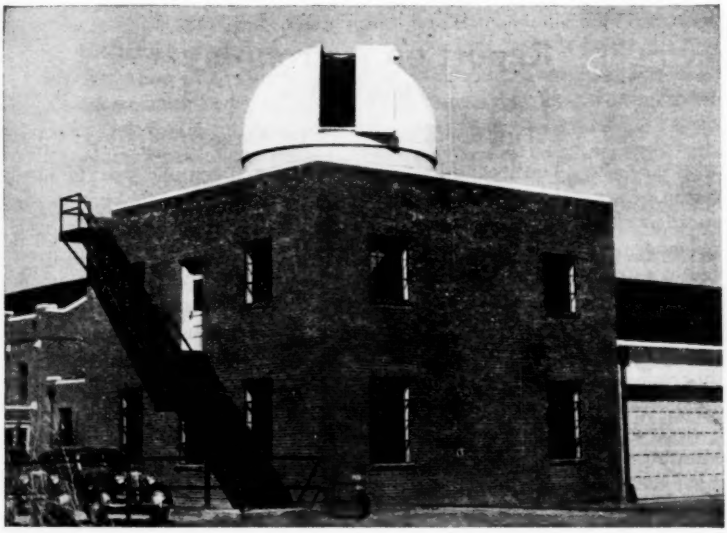
THE OBSERVATORY, UNIVERSITY OF MICHIGAN, June 10, 1939.

[5] *M.N.*, **26**, 299, 1866.

The New Observatory at the University of Oklahoma

By J. O. HASSLER

In September, 1938, the Department of Astronomy at the University of Oklahoma moved into its new observatory and plans to enlarge its program of work on variable and double stars. The equipment includes a 10-inch reflector (F-9 mirror by Mellish) of Newtonian type with attachments for photography. The plate-holder carries a 1⅝x4-inch plate. A 5-inch guiding telescope (reflector with F-9 mirror) is mounted on the tube of the main telescope. Stars of the fifteenth magnitude have been seen with the 10-inch telescope.



OBSERVATORY AT THE UNIVERSITY OF OKLAHOMA

The telescope has a synchronous motor drive with electric acceleration and deceleration in right ascension for guiding purposes and is mounted on a pier unattached in any way to the two-story building. It is also equipped with a filar micrometer. The mounting of the telescope and the accessories are the work of Mr. Charles Ridell of the Yerkes Observatory.

The University of Oklahoma Observatory also has a set of the new edition of the Franklin-Adams photographic charts. A dark room is equipped for developing, printing, enlarging, and making lantern slides.

For work in practical astronomy the observatory has an Essco student transit. A 3½-inch Gaertner portable refractor and a 6-inch Alvan Clark refractor are also available for student use.

The 10-inch telescope is housed in a 16-foot dome occupying one quadrant of a deck thirty-two feet square on which we expect to mount the two smaller telescopes. The large, open, flat roof, two stories up, surrounded by a coping three feet high, is ideal for use by elementary classes. On the floor below is located the office and chart room, a recitation room and the dark room. The dome is connected with the chart room below by a narrow service stairway. Both the first floor and the roof are accessible through an outside stairway.

The latitude of the observatory is $+35° 12' 8''$ and the longitude is $+97° 26' 37''$.

MAY, 1939.

Report on Astronomy*

By BART J. BOK

I. THE POPULARIZATION OF ASTRONOMY

(1) *Books.* The second half of the nineteenth century saw the publication of several excellent popular books on astronomy by such experienced writers as Flammarion, Sir Robert Ball, Newcomb, Lowell, Scheiner, and others; but it is rather striking to note that comparatively few popular books were published during the first two decades of the twentieth century. The small output of these years is not surprising if we realize that from 1900 to 1920 our views concerning stars and the structure of the universe were being revised completely, and that upon this revision were being laid the foundations of modern astronomy and astrophysics.

In 1921 Ludendorff, Freundlich, and Eberhard published the sixth edition of Newcomb-Engelmann's *Populäre Astronomie,* and we find in this excellent book a first homogeneous survey of the results of the ground-breaking work that had been done since the beginning of the present century. Some of the important researches that are recorded in

*The present article is the text of the report on astronomy for "The Committee on Science and its Social Relations." The existence and purpose of this committee were brought to the attention of readers of POPULAR ASTRONOMY in a note published in the June-July number of last year (POPULAR ASTRONOMY, **46**, 351, 1938). The material for the report was gathered through correspondence with astronomers in many parts of the world; I wish to take this opportunity to thank my friendly correspondents for their generous coöperation.

The full report contains a series of appendices to which reference is made at several places in the text. These appendices will not be published in POPULAR ASTRONOMY, but they will appear in printed form together with the report in *Harvard Reprint* 175. "The Committee on Science and its Social Relations" intends to use the present report as basic material for its general report that will appear later in the form of a book. B.J.B.

this book are: the discovery of star streaming; the researches in stellar statistics that led to the formulation of the Kapteyn system; Shapley's work on globular clusters; that of Schlesinger on stellar parallaxes, and of Adams and Kohlschütter on spectroscopic parallaxes; the publication of the Henry Draper Catalogue; the work of Pickering, Seares, and Miss Leavitt on stellar magnitudes; the discovery of the relationship embodied in the Russell-Hertzsprung diagram; the formulation of the theory of relativity and its bearing on astronomy; the first attempts to interpret the spectral sequence in terms of modern atomic theory (which was discussed in detail in the edition of 1922); the development of the pulsation theory of Cepheid variability; mathematical studies of the transfer of radiation through stellar atmospheres; the first attempts to investigate conditions in stellar interiors; and Russell's work on stellar evolution. The above listing is necessarily incomplete, but it shows that the time had come when scientists found it well worth their while to bring the intelligent reading public up to date through the publication of popular books on astronomy.

The publication of the sixth edition of Newcomb-Engelmann's *Populäre Astronomie* was very timely, and the impressive forward march of the years 1900 to 1921 that it sought to record has continued with even added momentum into the present. Among the recent important advances that have required proper interpretation in popular form are: the successful measurement of the distances of spiral nebulae; the exploration of the universe of galaxies, in particular at Mount Wilson and Harvard; the theory of the expanding universe; the discovery of the rotation of our galaxy; the recognition of the importance of the galactic interstellar medium and the study of its properties; the discovery of white dwarfs; photography of the corona outside eclipses; the taking of motion pictures of the chromosphere; the identification of the nebular lines and the interpretation of the physical phenomena in diffuse and planetary nebulae, O stars, novae, and supernovae; studies of the stellar temperature scale and of the contours of absorption lines in spectra; the study of planetary atmospheres; the discovery of Pluto; studies of energy generation in stellar interiors, which are intimately connected with research in nuclear physics; further work on stellar interiors; speculation on stellar evolution and the cosmic time scale; the development of the Schmidt camera; the construction of the 200-inch telescope; and miscellaneous discoveries (asteroids, comets, novae, etc.).

Some of the most significant books on astronomy and related subjects that have been published in English, French, and German have been listed in Appendices I to VI (for details see Section 2 of Part III). Since we are concerned here mainly with the problem of the popularization of astronomy, a few remarks on some of the most widely read popular books are in order.

The techniques of popular writing that have been employed in recent years have proved extremely successful in bringing modern astronomical

views to the attention of intelligent readers. For instance, it seems hardly necessary to remind the reader of the well-deserved popularity of the books of Eddington and Jeans which, in their original English texts as well as through translations, have reached interested laymen in all parts of the world. It is only natural that the techniques of popularization used by the most successful modern authors have been scrutinized by some of their colleagues.

Very careful analyses of the modern techniques of popularization employed in astronomy have appeared in *Nature*. Dingle has criticized the philosophies of Eddington and Jeans in his book *Through Science to Philosophy;* Eddington has replied in an essay review of Dingle's book in *Science Progress,* **32**, 772, 1938.

If one surveys the present trends in popular writing he will notice that modern authors have not always been careful to distinguish clearly between observations, established theories, useful working hypotheses (that could hardly be expected to survive for a very long time) and philosophical views and "hunches" that, interesting though they might be, would hardly be shared by many of their fellow-scientists. If the distinctions are not made clearly, the intelligent, non-scientific reader may become suspicious of the whole of science and cease to be interested, when he learns that some of the views expressed by an author are not held by anyone (including the author!) within a few years after the publication of a book. The reading public should be weaned away from a romantic faith in science and be taught that doubt in the validity of current hypotheses is basic for scientific research and advance. To this end, popular writers will do well to acquaint their readers more with the methods and techniques of scientific research than has been the general custom in recent years. It is also recommended that they return to the technique in which historical developments are stressed, since this procedure would enable the reader to judge for himself how a particular theory fits into the current picture.

(2) *Periodicals.* Several excellent popular and semi-popular astronomical magazines exist at the present time. *The Telescope, The Sky, Das Weltall,* and *Ciel et Terre,* to name only a few typical ones, publish mainly articles that can be understood readily by intelligent readers who may have done little or no previous reading in astronomy. Semi-popular magazines, which generally presuppose some knowledge of astronomy among their readers, are: *Popular Astronomy, The Journal of the Royal Astronomical Society of Canada, The Journal of the British Astronomical Association, L'Astronomie, Die Sterne,* and *Himmelswelt.* There are, in addition, magazines like *The Observatory* and the *Publications of the Astronomical Society of the Pacific,* which are in several respects on a level with the professional periodicals. For many years *The Astronomical Society of the Pacific* has published excellent popular articles in its *Leaflets,* and more recently *The Royal Astronomical Society* has be-

gun to publish for its non-professional members a series of non-technical articles under the title *Occasional Notes.*

Most of the general scientific magazines devote considerable space to astronomy. Excellent articles have appeared during recent years in: *Science Progress, Discovery, Scientia, The Scientific Monthly, Scientific American, Die Naturwissenschaften,* and—more infrequently—in *Nature* and *Science.* It is of interest in this connection to draw particular attention to Professor H. N. Russell's monthly article on some astronomical topic of current interest in *Scientific American,* and to the excellent survey articles that are published quarterly in *Science Progress,* neither series of which has received the world-wide attention to which it is entitled.

It would be a difficult matter to list all popular astronomical magazines that are published in other languages than English, French, and German. With considerable trepidation the following list is offered as including at least some of the leading journals in the field: *Nordisk Astronomisk Tidsskrift, Populär Astronomisk Tidsskrift, Hemel en Dampkring, Říše Hvězd, Coelum, Csillagászati Lapok, Revista Astronómica,* and the Japanese *The Heavens.*

(3) *Planetaria and Museums.* The development of the Zeiss Planetarium has been one of the most important stimulants for the popularization of astronomy throughout the world. Zeiss Planetaria are now in existence in Germany (10), the United States (5), Italy (2), Japan (2), Holland (1), Belgium (1), France (1), Russia (1), and Sweden (1); and with one or possibly two exceptions they are being operated on regular schedules. Reports from correspondents indicate that the erection of several additional planetaria is now under consideration. Most planetaria form the nuclei of institutions with excellent museum exhibits of astronomical instruments, meteorites, and celestial photographs. They are centers for the popularization of astronomy, and it is not surprising that at several planetaria there have sprung up active clubs of amateur astronomers and societies of interested laymen.

The public attendance at the planetaria appears to differ considerably from one country to the next. The planetaria in the United States continue to be popular, whereas reports of steadily decreasing attendance have come from some European countries. The success of the planetaria in Holland and Sweden indicates, however, that even countries with a comparatively small population can support a planetarium. Also, there is no reason why planetaria under competent direction should not be able to flourish in most cities with a total population in excess of five hundred thousand. A comparative study of successes and failures seems to bear out the contention that success comes to those institutions where, under enthusiastic leadership, the interest of the community is being stimulated constantly through special exhibits, lectures, and club meetings. Some of the American planetaria are issuing regu-

lar astronomical magazines. *The Sky*, published monthly by the staff of the Hayden Planetarium, is one of the finest of popular astronomical magazines.

Most planetaria have now adopted a scheme by which the topic under discussion is changed monthly, thereby encouraging listeners to become "repeaters" and eventually regular visitors. A certain amount of dignified publicity is not objectionable, and professional astronomers should not frown habitually on the planetarium director who attracts crowds through spectacular demonstrations. It is well, on the other hand, to emphasize that the displays should be dignified and accurate. No one should object to the dramatization of science, but scientists have every right to be aroused by displays that tend to cheapen it. The public will not continue to be interested in presentations of scientific methods and results if the fundamentals of scientific honesty are not strictly observed.

Scientific museums exist in one way or another in practically every country. The Deutsches Museum in Munich, the Science Museum in London, and the museums in New York, Chicago, and Philadelphia are the most popular of their kind. But often it is not realized that much can be done on a more modest scale. The planetarium that has been erected recently at Springfield, Massachusetts, in the United States (see POPULAR ASTRONOMY, **45**, 517, 1937) is a good example of a useful astronomical center built at comparatively small cost. We find many such centers scattered over the world, and, while they may not attract the large crowds drawn by a well-staffed large planetarium, they can do some very useful work.

(4) *Educational Projects.* A layman interested in astronomy may be intrigued by a book or article on the subject, or he may become enthusiastic because of a visit to a planetarium, but there is no thrill that quite equals that afforded by a visit to an active observatory. The opportunity to look actually through a large telescope and to hear directly from research astronomers about their work leaves an impression that is not readily forgotten. It is surprising that not more directors of observatories have realized the importance of public visits in the popularization of astronomy.

Every observatory, large or small alike, can find it within its means to arrange for successful public nights. At very little cost attractive transparency displays of photographs of stars and nebulae can be assembled. With the aid of even a small collection of slides it should be possible to give lectures that could not fail to stimulate thought among listeners. Views of celestial objects through comparatively small visual telescopes never fail to leave an impression. It is important to stress in this connection the need of school visits to astronomical centers of all kinds. Children between the ages of eight and eighteen are generally more interested in astronomy than most groups of adults. By arousing the interest in science at an early age, one lays the foundations for a fu-

ture generation with wide scientific interests. Directors of planetaria have generally recognized the importance of visits by schools; and it is highly desirable that directors of observatories should likewise encourage school visits, by setting aside certain nights or afternoons for the purpose.

The rapid growth of adult-education during the past two decades offers further possibilities for the popularization of astronomy. According to the answers received it appears that professional astronomers have shown definite interest in adult-educational projects in twenty out of twenty-nine countries. In those twenty countries it was generally reported that the attendance at astronomical lectures exceeded that in most other subjects. The organization of projects in adult education varies much from one country to another. In some countries we find people's universities or university-extension courses, in others lectures organized by civic groups; but whatever the nature of the organization may be, professional astronomers should realize that they are passing by very fine opportunities for public service if they do not respond to the evident desire for popular astronomical lectures.

The status of the teaching of the elements of astronomy in primary and secondary schools is unfortunately far from satisfactory. Only thirteen out of twenty-nine countries report the teaching of some elementary course in astronomy as a regular part of the school curriculum. This situation is all the more deplorable if one considers that most young people are eager to know more about the stars and the universe. If astronomy is taught at all in secondary schools it is too frequently considered as an illustration of the use of the principles of solid geometry and spherical trigonometry. It should instead find its place on every secondary school curriculum as a subject of major importance in developing the mind. The situation can be improved only if (1) secondary school authorities are made aware of the importance of the study of astronomy as a separate subject, and (2) more attention is given to the training of suitable teachers.

(5) *The Press and the Radio.* The daily press has reported in recent years whatever "exciting" astronomical news may have been brought to its attention in any part of the world. The emphasis, however, has been very definitely on specific news items, preferably of the nature of discoveries of some sort. On the whole the daily papers have printed very few general articles that would tend to throw light on the development of our world-picture as presented by astronomy.

The blame for this unsatisfactory state of affairs rests partly on the newspaper reporters and partly on the astronomers themselves. The daily press, for one, should be more eager to print articles about trends in science in the magazine sections of the Sunday editions, especially if the articles are illustrated with astronomical photographs; and astronomers, for their part, should take time off occasionally from research to

write such popular articles, or at least to give the necessary information to newspapermen (either in the form of personal interviews or by some other method), and to approve the copy before publication. Perhaps the best way out of the present *impasse* would be for the astronomers in each country to appoint one or more press-committees, whose duty it would be to facilitate relations between the press and the professional astronomers. Such committees could be very helpful also in interpreting for the press what is happening at meetings of astronomical societies. The establishment of personal contacts between representatives of a science and newspapermen is an essential element in scientific reporting. It would be well, therefore, if the members of the press-committees would arrange to meet at regular intervals with accredited newspaper representatives.

For the present the connections between astronomers and radio broadcasting stations are still weak in most parts of the world. Astronomers are "on the air" at regular intervals in some of the smaller countries, but very few lasting relations seem to have been established in the larger countries, with the exception of Canada and Soviet Russia. Very few astronomers—and the same holds for scientists in general—have acquired the correct technique of broadcasting. There is a wide open field for scientific broadcasting, and astronomers would do well to watch such opportunities.

(6) *The Spreading of Astrology.* One of the most deplorable developments of recent years is the rapid rise of public interest in astrology. Reports from correspondents indicate that the rise is particularly marked in the United States, Canada, the British Isles, South Africa, Australia, and the Netherlands. For some reason the astrological "wave" seems to have affected especially the countries where English is the dominant language. It is doubly serious that many second and third rate newspapers in English-speaking countries have succumbed to the fad and are now printing regular columns with astrological predictions.

The astronomers of the world should take a determined stand against this absurd pseudo-science. They should consider it their duty to inform the public on every possible occasion about the true nature of astrology, and to point out that the science of astronomy bears no relation whatever to it. Most intelligent people realize that astronomers are opposed to astrology, but the popular impression seems to be that here we have a case of two competing sciences, and it is not realized generally that astrology is completely fallacious. Lecturers in planetaria particularly are urged to take a strong stand against it. Its evil influence will never be killed if astronomers continue to be evasive on the subject; on the other hand, they would be performing a distinct service to humanity if they could succeed in wiping out astrological superstition among civilized people.

II. Amateur Astronomy

During the summer of 1937 the largest and one of the oldest of amateur astronomical societies, the *Société Astronomique de France,* celebrated its fiftieth anniversary. The rapid growth of public interest in astronomy may be judged by the fact that we find at the present time in practically every country one or more amateur astronomical societies. The organization of these groups differs very much in various places. Some countries, like Canada and France, have a single strong national society, frequently with branches in many cities; and others, like Switzerland and the United States, have many separate smaller societies. We shall proceed to describe briefly the organizations in the countries for which correspondents have kindly provided information.

France. The *Société Astronomique de France,* with its membership of 4500 (3000 French members, 1500 foreign members), is the largest single organization. It publishes an excellent journal, *L'Astronomie.* The most active French amateur observers are found in the *Association Française d'Observateurs d'Etoiles Variables,* with 200 members. This group publishes a bulletin in which are recorded the observations made by the members. There exist in many French cities small local societies, the best known of which is the *Association Astronomique du Nord* at Lille, which publishes a bi-monthly bulletin.

Great Britain. The *British Astronomical Association* (The *B.A.A.*) has a total membership of approximately 1000. It is one of the best organized societies for amateur observers. Valuable scientific contributions have been made by the association's observing sections on variable stars, sun, moon, Mars, Jupiter, Saturn, zodiacal light, and comets. Very useful work is being done also by the computing section, which performs the reduction of observations of occultations made by members of the *B.A.A.,* and also brings out yearly a useful *Handbook,* giving information that is not contained in the *Nautical Almanac.* There are at present thirteen special sections in the *B.A.A.* Membership is not limited to British subjects only; for example, the present director of its variable star section is Dr. Félix de Roy of Belgium.

The *B.A.A.* has an active Scottish branch, with a membership of 200. There is also a small local astronomical association in Edinburgh. In Glasgow are found the headquarters of the *Junior Astronomical Association,* a club which has members in many different countries and publishes a monthly journal *Urania.*

Germany. The two most important amateur associations are the *Bund der Sternfreunde* with 400 members and the *Vereinigung von Freunden der Astronomie und Kosmischen Physik* with 500 members. The *Vereinigung* . . . publishes the bi-monthly *Himmelswelt.* There is considerable interest in Vienna, where effective efforts toward the popularization of astronomy have been made at the Urania Sternwarte and the Astro-

nomisches Büro of Dr. Oswald Thomas. The *Astronomische Verein Wien zur Förderung der Meteorwissenschaft in Österreich* has a total membership of nearly 1000. Much of the popular interest in the vicinity of Berlin centers around the Treptow Sternwarte, where *Das Weltall* is published monthly.

Belgium. There is a national society, the *Société Belge d'Astronomie, de Météorologie et de Physique du Globe,* with a total membership of 360, and a local society at Antwerp. Members of the national society have made important contributions to our knowledge of meteors and variable stars. The *Société Belge . . .* publishes the magazine *Ciel et Terre;* the *Société d'Astronomie d'Anvers,* the *Gazette Astronomique.*

Netherlands. The *Nederlandsche Vereeniging voor Weer en Sterrenkunde* has branches in many cities of Holland; its total membership is 700. Until recently there had been a noticeable lack of active observers among Dutch amateurs. In the future, however, useful work may be expected from the *Phillips Observatory* of the amateurs at Eindhoven.

Scandinavian Countries. In Sweden the national society is the *Svenska Astronomiska Sällskapet* with a total membership of 250; this society publishes the *Populär Astronomisk Tidskrift.* In Denmark the *Astronomisk Selskab* has a total membership of 500 (some from Norway, Sweden, and Finland); its journal is the *Nordisk Astronomisk Tidsskrift.* The most recent addition to the group is the *Norsk Astronomisk Selskab* with 250 members. The Danish society has groups of observers of variable stars and occultations; some of the Swedish amateurs are well known for their work on novae, variable stars, and stellar photography; and the Norwegians are planning observations on aurorae.

Czechoslovakia. The largest single society is the *Czeckoslovakian Astronomical Society* with approximately 1000 members. There are three smaller societies with a total membership of approximately 700. The national society has sections for observers of variable stars, meteors, and solar activity. *Říše Hvězd* (The Realm of the Stars) is published by the national society.

Switzerland. Switzerland has no single national society, but several active local groups, of which the strongest is the *Gesellschaft der Urania Sternwarte Zürich* with a total membership of 360. Swiss amateurs have done some work on occultations, orbit computation, and variable stars.

Italy. The largest society is that at Turin, where the association *Urania* has 400 members. There is a smaller group at Bologna, but for the present there is no strong national society in Italy. Some isolated amateur groups observe variable stars. Two journals are published: the society *Urania* publishes a bi-monthly bulletin, and from Bologna comes the monthly *Coelum.*

Greece. The *Astronomical Society of Greece* has approximately 450 members. The society publishes a bulletin *Urania.* As yet there are only isolated amateur observers in Greece.

Soviet Russia. The Astronomical-Geodetical Society of the U.S.S.R., of which the central council and largest branch (224 members) are in Moscow, has a membership totalling 900. There are nine other branches in widespread large cities. Besides astronomy, the society's interests include geodesy, cartography, and gravimetry. Useful astronomical work is done on the observation of variable stars, moon, sunspots, planets, meteors, and comets, as well as on the reduction and publication of occultation data collected by the members. The society publishes a bulletin containing observations, ephemerides, and discoveries; and an almanac is issued by the Gorki branch. Many members of the central council, as well as of the councils of local branches are professional astronomers.

The Soviet government has made very successful efforts to bring astronomy to the masses. Astronomical lectures to school children, to groups of the Red Army, and to workers in factories and on collective farms are a regular part of the program. As an example of the scope of the activity we may quote that members of the staff of the Moscow planetarium gave, in 1938 alone, 1200 lectures outside the planetarium; 90,000 persons had views of the stars through telescopes, and the attendance at the regular planetarium lectures amounted to 900,000.

United States of America. There exists at present a great variety of amateur astronomical organizations in the United States; practically every large city has one or more. Some of the best known of these societies are: the *Amateur Astronomers Association* in New York, the *Rittenhouse Society* in Philadelphia, the *New Haven Astronomical Society* at New Haven, the *Skyscrapers* at Providence, the *Bond Astronomical Club* at Boston and Cambridge, the *Chicago Amateur Astronomical Association* at Chicago, the *Cleveland Astronomical Society* at Cleveland, the *Milwaukee Astronomical Society* at Milwaukee, the *East-Bay Astronomical Association* at San Francisco and Oakland, the *Joliet Astronomical Society* at Joliet, Illinois; a complete listing would include almost every city of some size in the country. There are some statewide associations such as the *Maine Astronomical Society* and the *Maryland Academy of Science,* but there is on the whole very little indication of organization on a large scale. The *Astronomical Society of the Pacific* has many professional astronomers among its 700 members; the papers in its *Publications* are largely too technical for the layman. *The American Astronomical Society* is a professional society.

For many years *Popular Astronomy* has been the unofficial journal of the American amateurs. Several local groups issue regular bulletins; that of the *Texas Observers* is one of the best.

One of the most interesting movements in the United States today is

the rapidly increasing enthusiasm for telescope making. Amateur telescope making has become one of the nation's greatest hobbies, and associations of telescope makers have sprung up everywhere. The movement has been stimulated chiefly through the regular page on the subject in *Scientific American,* and the publication of two books on *Amateur Telescope Making* by the editor of this journal, Albert G. Ingalls. There may be some doubt as to whether the activities of amateur telescope makers fall strictly under amateur astronomy, since most of the telescope makers are by nature mechanically inclined and show little interest in the persistent use of the finished instruments.

The total membership of amateur astronomical societies is of the order of 10,000, but probably not more than ten per cent of those members should be classified as active amateurs. Their most important scientific work has been done in the study of variable stars, meteors, and meteorites. The members of the *American Association of Variable Star Observers,* with headquarters at the Harvard College Observatory, have for nearly thirty years made important contributions to our knowledge of variable stars. The *A.A.V.S.O.,* as it is called, counts among its members many observers in foreign countries, but the bulk of the observing load is borne of course by the American amateurs. Some of the *A.A.V.S.O.* members are prodigious observers, through whose efforts some very notable contributions to our knowledge of variable stars and novae have been made. All observations are compiled and discussed by the official recorder, Mr. Leon Campbell.

In the field of meteors the *American Meteor Society,* with headquarters at the Flower Observatory, has rendered valuable service. The members of this society plot meteor paths and make hourly counts of meteors, following a scheme suggested by the director, Dr. C. P. Olivier. The *Mid-West Meteor Association* under the direction of Dr. C. C. Wylie has, in cooperation with the *American Meteor Society,* done much to increase the interest of amateur observers living in the central parts of the United States.

The *Society for Research on Meteorites,* of which H. H. Nininger and F. C. Leonard are the guiding spirits, is of recent origin. The work of this society stresses the intimate connections between astronomy, mineralogy, and geology.

It is important to notice that much of the effective work of amateurs in the three fields just mentioned has been made possible through the detailed and close guidance of some few professional astronomers.

Canada. The *Royal Astronomical Society of Canada,* with a total membership of 925, is one of the most effective amateur societies in the world. It has centers in nine leading Canadian cities, and publishes a *Journal* and an annual *Handbook.* Active interests involve meteor observing, work on variable stars, and telescope making. The *Journal* has as a regular feature "Meteor News" by Dr. Millman, in which ama-

teur observations are recorded.

South Africa. The *Astronomical Society of South Africa,* with 120 members, has its headquarters at the Cape of Good Hope. The society publishes annually a *Journal* with a circulation of 150. The members have been active in variable star observing, comet hunting, and making observations of zodiacal light.

Australia, New Zealand, and Tasmania. There exist a number of local societies, the most important of which are: the *Astronomical Society of Victoria* with 120 members, the *New Zealand Astronomical Society* with 95 members, and the *New South Wales Branch of the B.A.A.* with 85 members. Tasmania has a small society with 40 members. Valuable work is being done on observations of variable stars, the sun, meteors, planets, aurorae, zodiacal light, and occultations. The excellent work of the members of the *New Zealand Astronomical Society* in variable stars and meteors should be mentioned particularly. The New Zealand Society publishes a journal and the other three societies, regular bulletins.

China. The most prominent amateur astronomical society is the *Chinese Astronomical Society,* with a membership of 400; its official journal, which is published in Chinese, is called *The Universe.* The publication of the journal has not been interrupted by the Sino-Japanese war. Chinese amateurs have been interested in observations of variable stars.

Japan. The two national societies are: the *Japanese Astronomical Society* and the *Oriental Astronomical Association,* each with approximately 1000 members. There are in addition several local groups. The *O.A.A.* is organized along the lines of the *B.A.A.* in twelve sections. The sections on sunspots, meteors, zodiacal light, variable stars, and history are most active. The *O.A.A.* publishes *The Heavens;* the *Astronomical Society,* the *Astronomical Herald.* There is in addition a magazine called *The Milky Way.*

Other Countries. Amateur astronomical societies exist in other parts of the world. Poland, Egypt, and Mexico, for example, have small societies; Argentina has its society *Amigos de la Astronomia,* which publishes a journal called *Revista Astronómica;* and in Hungary the astronomical division of the *Royal Hungarian Society of Natural Science* publishes *Csillagászati Lapok (Astronomical Journal).* From several countries no reports were received; the most notable cases were Spain and Portugal.

The foregoing report shows clearly that amateur astronomy is flourishing today as never before. In most parts of the world interested laymen will find an amateur society waiting to enlist them as members. The success of the existing amateur societies is due in a large measure

to the active support that has been given them by professional astronomers. The replies from correspondents in twenty-nine countries indicate that professional astronomers occupy key positions in over 90 per cent of the active amateur societies.

Many fields of activity await the prospective amateur astronomer. An inspection of the reports of various countries shows that he can choose from a variety of fields, including variable stars; meteors; surface features of the sun, moon, or planets; comets; zodiacal light; aurorae; and occultations. If he prefers armchair astronomy he can reduce occultations, compute orbits, or study variable stars on photographic plates; and if he is technically minded he may satisfy his desires for performance through the making of mountings and mirrors for telescopes. Amateur astronomy is continually opening up new opportunities for closer relations with nature and for engrossing hobbies.

In this connection it is again of importance to stress the value of study of the stars among young people. Societies like the New York *Junior Astronomy Club* or the *Junior Astronomical Association* of Glasgow are highly important for the popularization of astronomy. It would be unfair to omit mentioning the Scout movement, which has more than any other youth organization tended to inspire young people the world over to obtain a fuller understanding of nature through the study of astronomy.

The interest of professional astronomers in amateur activities is not an indication of an unusual degree of social consciousness among this particular group of scientists. For many years amateur astronomers have been making important contributions to the advance of astronomy, and many of them have come to excel professionals in certain techniques of observation. Through their continued persistence they have collected large quantities of observations that would probably never have been gathered by professionals, simply because of lack of time. For example, it is difficult to think today of the study of variable stars, sunspots, or meteors without considering the contributions of enthusiastic and careful amateurs. It should be mentioned here that two most important additions to American observatories—the Cook Observatory in Wynnewood, Pennsylvania, and the McMath-Hulbert Observatory, now of the University of Michigan—were founded and operated by distinguished amateurs. Some of the most skillful discoverers of novae and comets are amateur astronomers. The value of their work has been recognized by the *International Astronomical Union,* on whose scientific commissions the most prominent amateur astronomers have served for many years. The steady advance of amateur astronomy is indeed one of the most cheerful developments of our times.

III. Reporting the Progress of Astronomy

(1) *Progress Reports and Abstracts of Papers.* It was pointed out in Section 2 of Part I that most of the popular and semi-popular astronomical magazines frequently print reports on scientific papers published in detail in technical journals or in regular observatory series. We shall have at this point only very little to add to the information that has already been given.

Important technical progress reports, written generally by experts in the field, are published annually by the Council of the *Royal Astronomical Society* in the February number of its *Monthly Notices.* Comparable reports are published by the *Astronomische Gessellschaft* in the *Vierteljahrsschrift,* often in the form of book reviews or reviews of groups of scientific papers. Excellent progress reports, which are frequently model treatises, have appeared in the German series, *Ergebnisse der Exakten Naturwissenschaften* (see Appendix VII for interval 1928-1938). The *Transactions of the International Astronomical Union,* published in book form after each meeting, contain in the reports of the various commissions the most widely referred to series of progress reports in the field of astronomy. In recent years the *Annual Report of the Director of the Mount Wilson Observatory* has become a very useful progress report.

Three publications have made it their business to print regularly abstracts of astronomical papers. Best known to astronomers is the *Astronomische Jahresbericht,* published annually. All significant papers are listed in this publication, which, because of its excellent index, completeness, and many cross references, has become the stand-by of astronomers the world over. The only objection to the *Jahresbericht* is that it is necessarily too delayed in publication to be of immediate value for a check-up on recent developments.

More current, but not quite so all-inclusive, are the English publication *Science Abstracts* and the newcomer to the field, the French *Bibliographie Mensuelle de l'Astronomie. Science Abstracts* selects its astronomical papers with considerable care. It is generally complete for astrophysical papers, but apparently does not aim at completeness for papers in stellar or classical astronomy. The *Bibliographie Mensuelle . . .*, published by the *Société Astronomique de France,* is one of the most useful reference series at the present time. Because of its prompt publication and apparent completeness it has found wide use among astronomers since it was first published in 1934.

An exceedingly valuable succession of progress reports appears monthly in the Bristish *Observatory* in the form of accounts of the proceedings at various meetings of the *Royal Astronomical Society.* We should mention finally the *Literarisches Beiblatt* of the *Astronomische Nachrichten,* in which are published lists of titles of scientific papers.

(2) *Books.** In Appendices I to VI have been listed some of the best known books on astronomy and related subjects that have been published since 1924-1925 in the English, German, and French languages. The list does not pretend to be complete, especially not for the popular books, but it is hoped that it may be representative; and although the classification is only a very rough one, it should be helpful to anyone who wishes to find the title of a book of a particular kind.

The *Handbuch der Astrophysik* and its *Ergänzungsband* are veritable gold mines for astronomical information. As the series should form a part of every astronomical library, it has not been felt necessary to reproduce here the entire list of articles.

(3) *The World-Picture of Modern Astronomy.** Readers who wish to inform themselves of the present state of knowledge in various fields of astronomical research will frequently find it extremely difficult to know just how to search for the most relevant papers on each subject. Accordingly, we shall attempt to list in Appendix VIII representative articles on those fields of astronomical endeavor in which most active research has been done in recent years.

Books will be referred to by their serial numbers in the various preceding appendices; for instance, "VI, No. 2" refers to book 2 of Appendix VI. Articles in the *Handbuch der Astrophysik* will be indicated by the letter "H" followed by the number of the volume in which the particular article appears. References to the *Ergänzungsband* will be indicated by the letter "E" followed by a page number. References to the *Transactions of the International Astronomical Union* will read "IAU" followed by a Commission number.

The references to papers in which attempts are made to summarize or coördinate progress in the different fields of astronomical research are listed directly following the book and *I.A.U.* references. References to papers will cover only the period from 1936 to the present time.

(4) *The Significance of International Coöperation in Astronomy.* In conclusion it is well that we devote a few paragraphs to the extreme importance for the advance of astronomy of close association among the astronomers of all countries. The total number of active research astronomers in the whole world is hardly more than five hundred, and it is probably because of the small total number that members of this group of scientists have been able to keep in close personal touch with one another. It is significant that scientific friendships have endured in spite of radical differences in political views. Astronomy has on the whole remained international in a world that has been moving more and more toward narrow nationalism.

The international aspect of the science of astronomy has been respon-

*The appendices will be published together with the report in *Harvard Reprint* 175.

sible in no small measure for its rapid growth during the past fifty years. Most astronomers correspond regularly with colleagues in their own and other countries, especially with those who are interested in similar lines of research. Meetings of one kind or another are frequent, and excellent use is made of opportunities for private discussion. Each astronomer can benefit continually, therefore, by the suggestions and criticisms of his colleagues, as well as by knowledge of the progress of their work that is as yet unpublished. It would be disastrous if this state of informal interchange of opinion were allowed to disappear, and astronomers must do everything in their power to foster continued close cooperation among the active workers in each field.

The existence of several national and international societies, such as the *Royal Astronomical Society,* the *Astronomische Gesellschaft,* the *American Astronomical Society,* and in particular the *International Astronomical Union,* is one of the best possible guarantees for continued close associations. The *I.A.U.* is at present one of the most effective unions largely because it brings together, once every three years, astronomers from all corners of the world. The meetings themselves are highly important; the Commission work has proved very valuable; and, as we have noted already, the reports of the various Commissions are among the best progress reports published today. But no one who has attended a single *I.A.U.* meeting would deny that he has benefited to a far greater extent from the personal relationships established there than from the formal meetings. Unfortunately there are still some countries that have been unable to join the *I.A.U.* It is to be hoped that soon the organization will include all countries in which active research in astronomy is in progress. Astronomers have regretted in particular that Germany has found it impossible to join, and we can only hope that the last obstacles may be removed in the near future. It has been extremely fortunate, however, that several German astronomers have taken active part in the meetings of the past ten years.

One clear indication that astronomers have felt the need for closer personal contacts is seen in the marked tendency toward the organization of astronomical symposia. In connection with most previous *I.A.U.* meetings a symposium of some kind had been arranged, but never before were such effective attempts made to bring astronomers together as during the Stockholm meeting in the summer of 1938. Astronomers have taken direct initiative recently for the organization of scientific symposia of an international character. The French astronomers held an excellent international symposium in the summer of 1937, and are holding another during the summer of 1939. Through the courtesy of the Warner & Swasey Company, an international symposium was held on the occasion of the dedication of the 82-inch reflector of the McDonald Observatory in Texas. The Harvard Observatory is organizing this summer its fourth series of summer conferences, which afford excellent opportunities for discussion, during a six-week period, among

astronomers of many nationalities. National symposia of different kinds are becoming more and more frequent, and with the rapid growth of astronomy such frequent personal associations among workers with common interests will be felt as an increasing necessity for proper coördination of current researches.

JULY 8, 1939.

Meeting of Section D (Astronomy) of the A. A. A. S. at Milwaukee

By HARLAN T. STETSON, *Secretary*

A meeting of Section D was held on Wednesday and Thursday, June 21 and 22, at which the Vice-President, Dr. Everett I. Yowell, presided. The Wednesday session was held in the Auditorium at Milwaukee and included contributions on a variety of topics in several fields of astronomy and astrophysics. Evidence that carbon dust periodically emitted from the star R Coronae Borealis causes the variation in brightness of that well-known variable was presented by John A. O'Keefe of the Yerkes Observatory, while Dr. Otto Struve discussed the chemical composition of interstellar gas. An unusual nebula with a cometary-like appendage was brought to the attention of astronomers by John Titus of the Yerkes Observatory. Paul Herget of Cincinnati gave his recent results on the satellite system of Jupiter. These papers were typical of the program which included altogether fourteen papers in the fields of astronomy and astrophysics. About sixty pople were in attendance in Milwaukee.

About seventy gathered at the Yerkes Observatory on Lake Geneva in Wisconsin for the Thursday session by special invitation of the Director, Dr. Otto Struve. Dr. Struve addressed the assembly on the topic, "The Yerkes Observatory Looks to the Future" and Dr. Ross of the Yerkes staff told of the history and development of the optics in astronomy, including the evaluation of many problems in connection with the construction of the 100- and 200-inch telescopes in California. A very pleasant social function was tea at the Director's residence by invitation of Dr. and Mrs. Struve, which followed the session at Yerkes. Opportunity was afforded those who stayed over into the evening to examine selected objects through the 40-inch Yerkes telescope. Participating in the program with the members of Section D were delegations from Milwaukee and The Chicago Astronomical Societies.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, JUNE 26, 1939.

The Effect of Lunar Eclipses on the Moon

By WALTER H. HAAS

The late W. H. Pickering called to the attention of astronomers the fact that a number of areas on the moon each lunation pass through a cycle of intensity-changes and suggested that these variations were to be explained by physical agencies, such as vegetation, frost, clouds, etc. Although it has been established that the changes occur essentially as Pickering described them, most astronomers prefer an alternative explanation, namely, that the changes are caused only by variations in the angle at which sunlight strikes the granulated lunar surface. A lunar eclipse affords us a splendid opportunity to choose between these two theories, physical change and incident light; for when the solar rays are temporarily withdrawn, the temperature of the moon's surface quickly falls very low, and when they are again supplied, it rises even more rapidly than it fell. Areas whose phenomena are those of physical changes would certainly be affected by such rapid and extreme temperature-changes; but areas depending only upon incident sunlight for their appearance would show no influence whatever. Because of the rapid rise of temperature after the eclipse, any effects would probably be very transient.

It is obviously desirable to examine each object we study both before and after the eclipse, observing each one as soon before it is covered by the earth's shadow and as soon after it emerges as is possible. And since the appearance may be changing rapidly just after the shadow's passage, it is wise to reëxamine each object frequently; for this reason, a program of observation should include only a few objects. We ought further to familiarize ourselves with the regions being watched before the eclipse and to make check observations near full moon in lunations near the one of the eclipse. One telescope at a constant magnification ought to be employed for all the observations. If the condition of the sky varies while the program is being executed, we must attempt to allow for this influence when interpreting results.

The first lunar eclipse observed with the purpose just discussed in mind was that of December 27, 1898.[1] Pickering observed the Riccioli dark area, the Alphonsus dark spots, the Olbers dark spot, Schroeter's Valley, Pytheas, a craterlet in Serenitatis, a dark area west of Webb, and the spot around Linné. The first six showed no effects, the seventh may have been lightened by the shadow's passage, and results on the eighth were inconclusive. At Pickering's request A. E. Douglass measured Linné at Lowell Observatory and found an enlargement of about 0".5, lasting perhaps for thirty minutes. The next eclipse studied was

[1] "Eclipse of Dec. 27, 1898," W. H. Pickering, *H.A.*, **32**, 256-62.

that of December 16, 1899.[2] This time Pickering selected for study Schroeter's Valley, the plain near Webb, the Riccioli dark area, and Linné. The first three were unaffected; the last may have been enlarged by 0″.14. At the eclipse of October 16, 1902,[3] Pickering found a striking enlargement of the Linné spot, fully 2″.75. The spot had changed so much that he actually doubted its identity when it emerged from shadow, even though he was very familiar with the region. There was no diminution in size for forty-five minutes, after which the sky became cloudy. At the eclipse of April 11, 1903,[4] Pickering observed an enlargement of 0″.55; of this amount, 0″.35 was gone seventy-five minutes after Linné emerged from the shadow. The amount of the enlargement was confirmed by Saunder of the B.A.A. The eclipse-enlargement of Linné had also been observed by Dr. Wirtz of Strassburg Observatory, Germany, by this time.[5]

From a study of Pickering's files conducted in June, 1935, I found that he observed several more eclipses, that most varying lunar regions were unaffected, and that the green color of the Grimaldi floor was sometimes influenced.

The first eclipse I observed was that of July 16, 1935. No effects were detected on Plinius, the east inner wall of Aristarchus, the Theophilus peaks, or the Grimaldi floor; but Linné was possibly enlarged for thirty minutes after emergence, micrometer-measures being poor; and the south end of the Riccioli dark area was probably absent just after totality. Only Noah W. McLeod of Christine, North Dakota, observed the eclipse of May 14, 1938. He found the south tip of the Riccioli dark area gone for thirty minutes after reëntering sunlight and suspected that the spots along the west wall of Grimaldi were brightened by the shadow's passage. Hampered by haze and bad seeing at the eclipse of November 7, 1938, I restricted myself to micrometer-measures of the length of the Riccioli dark area and the diameter of the Linné spot, making the measures by the between-the-threads method. The former appeared to lengthen by 4″.4 from one hour to three hours after emerging from shadow, and the latter appeared to diminish by 0″.8 from one hour to two hours after emergence. The preceding results would indicate that the end of the Riccioli area had faded and that Linné had enlarged itself—just as previous work would have led us to predict. Some doubt is cast on these results by the poor conditions of observation, but it is likely that much larger variations would have been detected if only observations could have been begun while the shadow was leaving the moon. Hugh Johnson in Des Moines had very poor conditions; his observations may indicate that the dark areas in the eastern part of the floor

[2] "Lunar Changes during Eclipse of Dec. 16, 1899," W. H. Pickering, *P.A.*, **8**, 57, 1900.

[3] "Total Lunar Eclipse of Oct. 16, 1902," E. C. Pickering, *Harvard Circular* 67.

[4] Linné, Plato, Messier," W. H. Pickering, *H.A.*, **51**, 24-27.

[5] "Coming Total Eclipse of the Moon," W. H. Pickering, *P.A.*, **14**, 4-5, 1906.

of Eratosthenes were lightened. J. Russell Smith of Smyer, Texas, found no changes in the Riccioli dark area or the Grimaldi spots, first observing them forty minutes after they reëntered sunlight. Five amateur astronomers in Youngstown, Ohio, (John Chase, Leo Grandmontagne, E. A. Miller, Martin Bachner, and Richard Shaner) found Grimaldi's floor for a time much darker than the neighboring maria, but it lost this distinction two hours after emerging. Forty minutes later they found that the south end of Grimaldi had merged with the region outside the crater. Ball of the B.A.A. found no effect on "areas where traces of vegetation had been suspected."[6]

Fauth, the famous German selenographer, suggested that the transient enlargement of Linné was an illusion, caused by the temporary dazzling of the observer's eye when the moon leaves the shadow and again receives sunlight.[7] As the observer's eye accustomed itself to the brilliant full moon, he saw Linné in its true size; and his measures grew smaller. I do not consider such an explanation likely. First, Linné lies near the center of the moon; and the observer has been looking at uneclipsed parts of the moon for some time before the spot in question emerges. Second, it is not likely that the eye would continue to be dazzled for half an hour; yet Linné has been measured as enlarged even longer.

A consideration of the preceding observations enables us tentatively to make three statements about the effects of eclipses:

1. Most areas, even when exhibiting periodic changes, are unaffected; and the effect is usually, if indeed not always, slight.
2. Some actual effects are produced, some arrests or reversals of normal development. The incident light theory cannot explain these phenomena, and physical changes must be involved.
3. The same object may be differently affected at different eclipses.

On October 28, 1939, the moon will be almost totally eclipsed; the circumstances are as follows:

	d h m	
Moon enters penumbra	Oct. 28 3 41.8	U.T.
Moon enters umbra	4 54.5	"
Middle of eclipse	6 36.2	"
Moon leaves umbra	8 18.2	"
Moon leaves penumbra	9 30.9	"

Magnitude of eclipse = 0.992 (Moon's diameter = 1.0)

We thus see that mid-eclipse comes at 1:36 A.M. on October 28, E.S.T., at 12:36 A.M. C.S.T., at 11:36 P.M. on October 27, M.S.T., and at 10:36 P.M. P.S.T. The moon's declination is +12° and its meridian altitude will be 62° in latitude +40°, 67° in latitude +35°, and 72° in latitude +30°. In short, observers all over the United States are splendidly placed for observing this eclipse, and it is hoped some of them will attempt to do so. I would welcome correspondence about this matter.

[6] "Report of Ordinary General Meeting," *J.B.A.A.*, **49**, 58, 1938.
[7] *The Moon*, by Philip Fauth.

Linné is the best object for observers having micrometers; the Riccioli dark area, for those lacking them. Grimaldi deserves attention; the spots along the west wall and the color and darkness of the floor should be observed. The dark area near Webb and the ones in Eratosthenes might repay study. There are many other possible objects, for this problem is largely an unexplored field.

I am much indebted to Dr. J. J. Nassau, director of the Warner and Swasey Observatory of the Case School of Applied Science in Cleveland, for suggestions about observing the eclipse of November 7, 1938.

2009 Taylor Road, East Cleveland, Ohio, March 29, 1939.

Planet Notes for September and October, 1939

By R. S. ZUG

Note: Greenwich Civil Time is employed unless otherwise stated. To obtain Eastern Standard Time subtract 5 hours, Central Standard Time, 6 hours, etc. The planetary phenomena are described as they are to be seen from latitude 45° N. The data are taken chiefly from the *American Ephemeris and Nautical Almanac*.

Sun. Apparent positions of the sun are as follows:

	α	δ
	h m	° ′
September 1	10 37.4	+ 8 41.8
October 1	12 25.4	— 2 44.7
November 1	14 21.2	—14 4.2

The sun will be moving through the constellation Leo until September 16, when it enters the constellation Virgo. It remains in the latter constellation until October 31, when it enters Libra. The fall season begins on September 23 at $22^h\ 50^m$, with the passage of the autumnal equinox by the sun. Values for the equation of time are as follows:

Date 1939	Equation of Time (Mean - Apparent) m s	Date 1939	Equation of Time (Mean - Apparent) m s
Aug. 31	+ 0 39	Oct. 2	—10 15
Sept. 4	— 0 37	6	—11 30
8	— 1 56	10	—12 38
12	— 3 19	14	—13 40
16	— 4 43	18	—14 33
20	— 6 8	22	—15 17
24	— 7 32	26	—15 51
28	— 8 55	30	—16 13

Moon. Phenomena of the moon will occur as follows:

		h m
Last Quarter	Sept. 6	20 24
New Moon	13	11 22
First Quarter	20	10 34
Full Moon	28	14 27
Last Quarter	Oct. 6	5 27
New Moon	12	20 30
First Quarter	20	3 24
Full Moon	28	6 42

		h	m
Perigee	Sept. 12	18	
Apogee	25	9	
Perigee	Oct. 11	1	
Apogee	22	23	

Eclipses. A total eclipse of the sun will occur on October 12. The eclipse will be total in the Antarctic Circle, and it is interesting to note that the eastern edge of the path of totality lies some 470 miles to the west of Little America. The eclipse may be seen as partial in eastern Australia, New Zealand, the southern part of South America, and points in the South Pacific Ocean. For details and a chart of this eclipse, see POPULAR ASTRONOMY for January, 1939, p. 30.

A partial eclipse of the moon occurs on October 28. The beginning is visible generally in Europe except the extreme eastern part, the western part of Africa, the Atlantic Ocean, North and South America, the eastern part of the Pacific Ocean, and the northeastern extremity of Asia. The ending is visible generally in the North Atlantic Ocean, the Arctic Ocean, North and South America, the Pacific Ocean, Polynesia, the eastern part of Australia, and northeastern Asia. For observers in North and South America, the eclipse begins on the evening of October 27 and ends on the morning of October 28 (Local Time). The eclipse will attain magnitude 0.992, and will therefore be almost total. Circumstances of the eclipse are are follows:

	Greenwich Civil Time			
		d	h	m
Moon enters penumbra	Oct.	28	3	41.8
Moon enters umbra		28	4	54.5
Middle of eclipse		28	6	36.2
Moon leaves umbra		28	8	18.2
Moon leaves penumbra		28	9	30.9

Mercury. Mercury will be a morning star during the first part of September. During the first two weeks of the month the planet should be visible just before sunrise a few degrees above the horizon, and some 10° north of the east point. The stellar magnitude of 0.0, attained on August 29, changes rapidly as the brightness of the planet increases, and reaches —1.3 on September 13. The planet becomes an evening star on September 22, at 14^h, when it reaches superior conjunction with the sun.

Venus. Venus will be in superior conjunction with the sun on September 5 at 20^h. At conjunction the planet will be situated 1°.1 north of the sun's northern limb, and will be of stellar magnitude —3.5. The angular diameter of the planet, at conjunction, will be 9".7. By October 1 Venus should be discernible shortly after sunset, as a low evening star.

Mars. Mars will still be conspicuous during September and October. It will be located in the constellation Capricornus, and will be a fine object for observation, although rather too far south for observers in northern middle latitudes to expect "good seeing." Additional information follows:

Date	Distance from Earth (Miles)	Angular Diameter	Stellar Magnitude
Sept. 1	43,173,000	20".1	—1.8
Oct. 1	56,960,000	14.2	—1.0
Nov. 1	75,259,000	11.6	—0.4

Jupiter. Opposition of Jupiter and the sun will occur on September 27 at 19^h. At the time of opposition, its distance from the earth will be 367,100,000 miles, and

the angular polar diameter, 46".5, while the stellar magnitude will be —2.5. Jupiter will occult the ninth magnitude star, B.D. —1°3, October 19-20. The occultation will be visible throughout Europe, Africa, Central and Western Asia, and South America, according to Mr. Arthur Burnet, who gives us the information in "Occultations by Planets," in *The Handbook of the British Astronomical Association.* The emersion, and possibly the immersion, should be visible also from the eastern portion of North America. The period of occultation is, approximately, from October 19, $22^h\ 5^m$, to October 20, $0^h\ 10^m$.

Saturn. Saturn is in opposition with the sun on October 22. At this time the rings will measure 45".2 and 11".5 in greatest and least angular diameter, respectively, the southern side of the rings being visible. The stellar magnitude will be +0.1 at opposition.

Uranus. Uranus is located in the constellation Aries, and apparent positions for it are listed below:

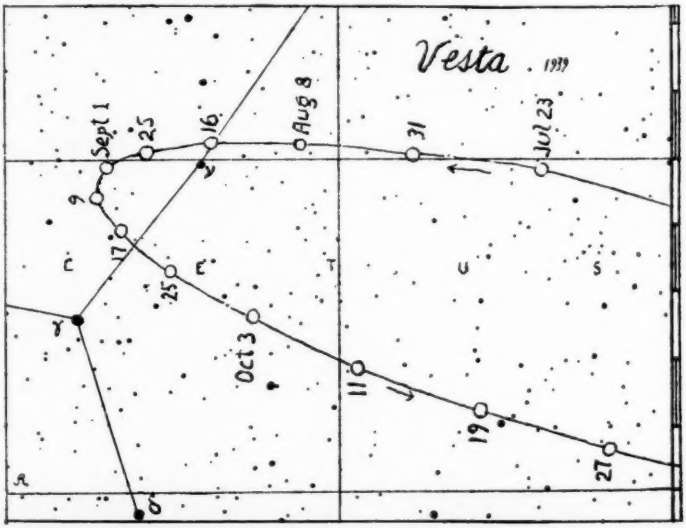
	α	δ
	h m	° ′
September 1	3 18.5	17 56.7
October 1	3 16.7	17 49.7
November 1	3 12.4	17 32.9

Neptune. The planet Neptune will reach conjunction with the sun on September 16.

Asteroid Notes

By HUGH S. RICE

Two of the "big four" of the asteroids are available for observation with small telescopes during the last half of the summer. The first is Juno, whose chart appeared in the preceding issue of this magazine, this chart being still good until the



end of the year. Juno's magnitude is 8.5 on August 1, but 8.3 during most of August and September.

The second minor planet is Vesta, whose chart is herewith reproduced. Vesta is in Cetus, and the magnitude is 7.5 on August 1, changing gradually to 6.9 by October 1. Its turning point before retrograding lies within the head of Cetus, as outlined on the chart.

Ephemerides were furnished by the Coppernicus Institute, the new name of the Astronomisches Rechen-Institut at Berlin-Dahlem, Germany.

Hayden Planetarium, American Museum of Natural History,
New York City, July 15, 1939.

Occultation Predictions

(Taken from the *American Ephemeris*)

Date 1939	Star	Mag.	IMMERSION Greenwich C.T.	IMMERSION *a*	IMMERSION *b*	IMMERSION Angle E from N	EMERSION Greenwich C.T.	EMERSION *a*	EMERSION *b*	EMERSION Angle E from N
			h m	m	m	°	h m	m	m	°
Occultations Visible in Longitude +72° 30′, Latitude +42° 30′.										
Sept. 3	54 Cet	5.9	8 36.8	—2.0	—0.1	84	9 59.8	—1.6	+0.5	234
6	68 Tau	4.2	7 11.5	—1.6	+0.3	114	8 13.5	—1.0	+2.6	222
9	λ Gem	3.6	6 32.2	0.0	+0.7	111	7 24.6	—0.1	+1.5	255
Oct. 3	162 B.Tau	6.3	1 40.5	+0.6	+2.4	30	2 18.3	—0.4	+0.4	305
3	180 B.Tau	6.1	5 8.7	—1.8	0.0	119	6 5.1	—0.9	+3.1	214
4	*m* Tau	5.0	7 25.1	—1.7	+1.4	76	8 47.6	—2.0	0.0	274
5	BD+18°1112	6.4	11 38.1	—1.2	—2.8	139	12 37.2	—1.9	+0.4	238
8	60 Cnc	5.7	6 45.9	0.0	+1.5	84	7 40.8	—0.5	+0.4	299
18	BD—18°5079	6.5	21 29.1	—1.9	+1.3	47	22 44.3	—2.3	—1.2	293
21	45 B.Cap	6.2	1 41.0	..	..	9	2 21.9	..	..	306
30	148 B.Tau	6.0	5 11.4	—1.3	+3.1	34	6 13.1	—2.4	—1.7	300
30	162 B.Tau	6.3	9 36.0	—1.0	—1.6	102	10 42.9	—0.8	—0.8	252
Occultations Visible in Longitude +91° 0′, Latitude +40° 0′.										
Sept. 3	54 Cet	5.9	7 57.1	—1.9	+1.4	69	9 25.3	—1.9	+1.0	242
6	68 Tau	4.2	6 49.4	—0.7	+1.1	99	7 51.3	—0.6	+2.1	236
25	c^1 Cap	5.3	7 1.3	—1.1	—1.2	89	8 6.7	—0.3	+0.2	224
Oct. 3	180 B.Tau	6.1	4 45.4	—0.7	+1.0	103	5 44.9	—0.5	+2.3	229
4	*m* Tau	5.0	6 57.4	—0.9	+2.0	67	8 10.9	—1.6	+0.6	276
5	BD+18°1112	6.4	11 26.3	..	..	175	11 42.3	..	..	196
30	148 B.Tau	6.0	4 47.6	—2.0	+4.4	17	5 30.0	—2.6	—1.7	312
30	162 B.Tau	6.3	9 14.4	—1.7	—2.1	118	10 21.8	—1.6	+0.6	231
30	180 B.Tau	6.1	13 16.2	+0.2	—2.2	128	14 1.0	—0.2	—0.1	231
Occultations Visible in Longitude +120° 0′, Latitude +36° 0′.										
Sept. 3	54 Cet	5.9	7 15.0	—0.5	+2.5	41	8 23.8	—1.6	+1.0	270
6	68 Tau	4.2	6 41.3	+0.3	+1.2	81	7 35.8	0.0	+1.3	256
25	c^1 Cap	5.3	6 13.7	—1.9	+0.7	60	7 42.1	—1.6	+0.1	244
Oct. 3	180 B.Tau	6.1	4 36.9	+0.3	+1.1	86	5 31.0	—0.1	+1.5	250
3	68 Tau	4.2	14 55.0	—0.9	—2.6	127	15 52.6	—1.2	+0.2	233
4	*m* Tau	5.0	6 40.8	+0.3	+2.2	46	7 31.1	—0.8	+0.4	295
5	19 B.Gem	6.2	11 49.5	..	..	19	12 14.3	..	..	345
7	BD+14°1850	6.4	13 34.5	..	..	170	14 10.8	..	..	221
8	κ Cnc	5.1	12 6.8	—1.0	—2.1	157	12 50.0	—1.3	+3.0	234
25	25 Psc	6.2	10 36.2	—0.4	+0.9	34	11 26.7	—0.1	—2.0	287
30	162 B.Tau	6.3	8 11.7	—2.7	—1.0	118	9 18.7	—1.8	+2.9	216
31	*m* Tau	5.0	14 45.5	—0.8	—0.6	75	15 45.2	—0.1	—1.8	295

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

The reported activity of the A.M.S. observers in the United States itself has been very small, as is evidenced by the data so far received. By far the most extensive contribution again comes from India, where Professor Khan continues his good work, all the more important because in past decades reports from his great country have been almost non-existent. We also have an interesting report on the Lyrid maximum from Loreta in Italy. Both Loreta and Khan agree that the return was an inconspicuous one. The Eta Aquarids of early May were spoiled by the light of a full moon. Nobody apparently made any attempt to observe them, at least no reports have arrived.

If, however, routine reports have been few, our country has recently been favored by a number of splendid fireballs. Particularly the one seen over Texas on 1939 May 2, 7:25 P.M., C.S.T., has been extensively studied by F. F. Fouts and J. J. King of Houston, Texas. They have sent me a set of splendid photographs of the long-enduring train, as well as of a meteorite they secured from the fall. They are revising the accompanying article and I hope to have it appear in later "Meteor Notes."

An even more spectacular fireball appeared over Oregon and Washington at 8:00 A.M. on July 2 (civil date), which is being fully investigated by our able regional director Professor J. F. Pruett, of the University of Oregon. Eventually we hope to have the full report on this also published in "Meteor Notes."

A fine fireball was seen over eastern Pennsylvania and New Jersey on 1939 June 26 at 8:40 P.M., E.S.T. Due to some misunderstanding on the part of the reporter in whose hands I put the request for observations from the public, the request was ambiguously worded and so only a few reports came in. Perhaps, however, enough will turn up to compute its height.

I have also received through the Weather Bureau a long and interesting account, written by H. J. Detrick, on the siderolite which fell at Pantar in the Philippines on 1938 June 16 at about 8:45 A.M. This also left a persistent smoke-cloud, of which I received one photograph.

Thanks to the great increase of public interest in such phenomena we can confidently expect that more and more will be reported annually, and that the data will be more nearly accurate.

We have reason to believe that several groups plan extensive work on the summer and fall showers. It is hoped that this will be carried out with success

and that succeeding "Meteor Notes" will have more of current interest to report.

Observer and Station	Date	Began	Ended	Total	F.	Met.	*
Rademacher, Mrs. G. C.,	1938 Nov. 14	11:30	12:30	60	0.7	4	
Handen, Connecticut	1939 Apr. 22	10:40	12:20	100	0.5	8	
Pirsig, G., Blue Earth, Minnesota	May 15	9:27	10:27	60	0.7	7	
	16	9:15	10:45	90	0.9	11	
Wallace, Wm., East Cleveland, Ohio	May 9	11:00	13:35	155	1.0	9	
	13	11:05	14:20	195	1.0	7	
	16	11:00	13:30	150	1.0	10	
Hardy, C., Fremont, Ohio	June 25	10:30	15:30	258	0.7	35	
	26	10:30	15:30	300	0.4	32	
	30	11:00	13:00	120	0.4	4	
Klan, P., Dubuque, Iowa		misc.				18	(1)
Loreta, E., Bologna, Italy	Apr. 15	9:00	9:55	50		3	
	16	9:30	10:25	50		5	
	17	9:00	10:25	75		5	
	20	10:00	12:55	150		20	(2)
	21	10:00	13:55	200		38	(3)
	22	10:00	13:25	175		28	(4)
	23	10:00	13:25	125		10	
	24	10:00	11:25	75		9	
Khan, Professor Mohd. A. R.,	Jan. 17	21:05	22:05	60	0.8	7	(5)
Begumpet, India	18	20:30	21:00	30	0.7	7	
	24	20:15	21:00	45	0.8	11	
	27	20:15	21:00	45	0.7	7	
	28	20:30	21:00	30	0.8	6	
	30	20:45	21:30	45	0.8	3	
	Feb. 25	21:20	22:20	60	0.9	11	
	26	22:30	23:30	60	1.0	14	
	28	21:25	22:30	65	1.0	15	
	Mar. 14	21:00	21:30	30	0.9	7	
	15	20:15	21:30	75	1.0	12	
	17	20:20	21:30	70	1.0	17	
	18	20:30	21:30	60	1.0	8	
	19	20:30	21:30	60	1.0	9	
	27	20:45	21:30	45	0.9	8	
	Apr. 9	19:30	20:30	60	0.3	4	
	10	19:05	19:35	30	0.5	6	
	16	21:15	22:15	60	1.0	6	
	20	19:50	20:30	40	1.0	5	(6)
	21	20:45	22:00	?	0.5	6	
	22	19:20	21:30	100	0.9	17	
	24	19:05	20:30	85	1.0	20	
	May 16	20:30	21:30	60	1.0	9	
	17	19:30	20:00	30	1.0	5	
	19	20:50	22:00	70	0.9	14	
	23	22:00	22:30	30	0.7	5	
	27	20:15	23:10	65		7	
	June 10	19:15	20:00	45	0.8	8	
		misc.				27	

*(1) Observed in April and May. *(2) 8 of these Lyrids. *(3) 17 of these Lyrids. *(4) 11 of these Lyrids. *(5) Hours are in U.T., which is counted from Greenwich midnight. To get local time at Begumpet, add $5^h\,12^m$ to hours given. *(6) 2 Lyrids on April 19 gave rad. $\alpha = 18^h\,5^m$, $\delta = +33°$.

Flower Observatory of the University of Pennsylvania,
1939 July 13.

Contributions of the Society for Research on Meteorites

Edited by FREDERICK C. LEONARD,
Department of Astronomy, University of California, Los Angeles

President of the Society: H. H. NININGER, Colorado Museum of Natural History and American Meteorite Laboratory, Denver

Secretary of the Society: ROBERT W. WEBB, Department of Geology, University of California, Los Angeles

Three New Siderites from Kentucky: Campbellsville, Clark County, and Providence*

By DAVID M. YOUNG,
Department and Museum of Geology, University of Kentucky, Lexington

ABSTRACT

On June 3, 1929, the seventeenth Kentucky meteorite (Campbellsville) was ploughed from a field by Mr. E. B. Watson on the farm of Edgar Cox, near Campbellsville, Taylor County, Kentucky. The original weight of the iron was 34 pounds, about one-half of which has been distributed. It is classed as a coarse octahedrite (Og) and has the following chemical composition: iron, 88.99%; nickel, 10.27%; cobalt, 0.26%; and traces of carbon, silica, manganese, copper, and titanium.

The eighteenth meteorite from Kentucky (Clark County) was found in 1937. It was purchased by Mr. J. D. Figgins of the Bernheim Museum, who exchanged most of it with the American Meteorite Laboratory, where it will be described. The original weight was 26 pounds.

The latest identification of a siderite in Kentucky (Providence) was made in July, 1938, although the specimen was found 35 years before. Mr. W. T. Yeager, owner of a farm located about one mile southwest of Providence, Trimble County, Kentucky, found the iron in 1903 in an orchard where it was exposed at the surface of the ground. Unaware of its true character, but interested because of its weight, he kept the specimen as a curiosity until it became known to the writer. The weight is 15 pounds, and although badly oxidized, the coarse octahedral crystallization is well defined. The meteorite is classed as a coarse octahedrite (Og) and contains 88.54% iron, 10.30% nickel, 0.30% cobalt, *etc.*

The seventeenth Kentucky meteorite was found on the farm of Edgar Cox, located on the waters of Stoner Creek, near Campbellsville, in Taylor County. The finder, E. B. Watson, was ploughing virgin land on top of a ridge when the iron was unearthed. His attempts to break the mass with a sledge and to cut it with a small hacksaw proving unsuccessful, he decided to bring the specimen to Lexington for identification. It was first seen by a reporter on the *Lexington Herald*, who directed Mr. Watson to the Department of Geology of the University. It was identified as of meteoric nature by Dr. A. C. McFarlan, Head of the Department, who removed a section for the United States National Museum. The iron first came to the attention of the writer in 1932.

The mass as found weighed 15.422 kg., had a maximum length of about 22

*Read by title at the Sixth Annual Meeting, Richmond, Virginia, December, 1938.

cm., and a maximum thickness of about 15 cm. Crystallization was not evident on the weathered surface, but polishing and etching revealed excellent Widmanstätten figures. The kamacite lamellae have a thickness of from one to 2 mm., and are mostly of the granular variety. The thin plates of taenite are well defined, and plessite is abundant. No troilite has been noted in quantity on the sections examined. The iron is classed as a coarse octahedrite (Og). It is named the Campbellsville, Taylor County, siderite.

Analysis by Dr. J. S. McHargue of the University of Kentucky Experiment Station gave the following results:

Fe	88.99%
Ni	10.27
Co	0.26
Cu, Si, Mn, C, Ti	Trace

This iron has figured in numerous exchanges, which have been largely responsible for the increase in the number of Kentucky meteorites represented in the collection of the Museum of Geology, University of Kentucky. Prior to the writer's connection with the University of Kentucky, 4 of the 19 Kentucky meteorites were represented. This number has been increased to 14, largely as a result of the Campbellsville exchanges. Distributions are as follows:

University of Kentucky	9639 g.
U. S. National Museum	240
Harvard University	465
Miami University	250
Ward's Natural Science Establishment	1340
British Museum	480

The eighteenth Kentucky meteorite, the Clark County siderite, was found in 1937 in southern Clark County, Kentucky. It was purchased by Mr. J. D. Figgins, Director of the Bernheim Museum, who exchanged it with the American Meteorite Laboratory of Denver, Colorado, where it will be described. The original weight was 26 lbs., of which 2.280 kg. have been reserved for Kentucky collections.

The nineteenth meteorite to be recorded from the State of Kentucky was obtained by the writer for the Museum of Geology, University of Kentucky, on July 12, 1938. It was found in 1903 on the farm of Mr. Tom Yeager, located about one mile southwest of Providence, in eastern Trimble County. The specimen had been kept for 35 years by the finder, Mr. Yeager, as a curiosity, but without knowledge of its true identity. In the spring of 1938, a worker for the Kentucky State Highway Department saw the meteorite and was attracted by its unusual weight and toughness. It was borrowed from the owner and taken to the State Highway offices in Frankfort. The writer, hearing indirectly of the matter, asked that the specimen be submitted for examination. The request was granted and the meteoritic nature of the iron was determined. Well-defined octahedral crystallization was visible on the weathered surface, and etching of a polished surface revealed excellent Widmanstätten figures.

The owner of the meteorite was communicated with, and a visit to the place of find was arranged. The meteorite was picked up, according to Mr. Yeager, from the surface of the ground in an orchard. Mr. Yeager stated that in the 35 years ensuing since the find, occasional attempts had been made to locate additional pieces of the iron without success. At this point it should be said that lack of funds has prevented adequate examination of not only this site but all localities where iron meteorites have been recovered in Kentucky. Instrumental surveys

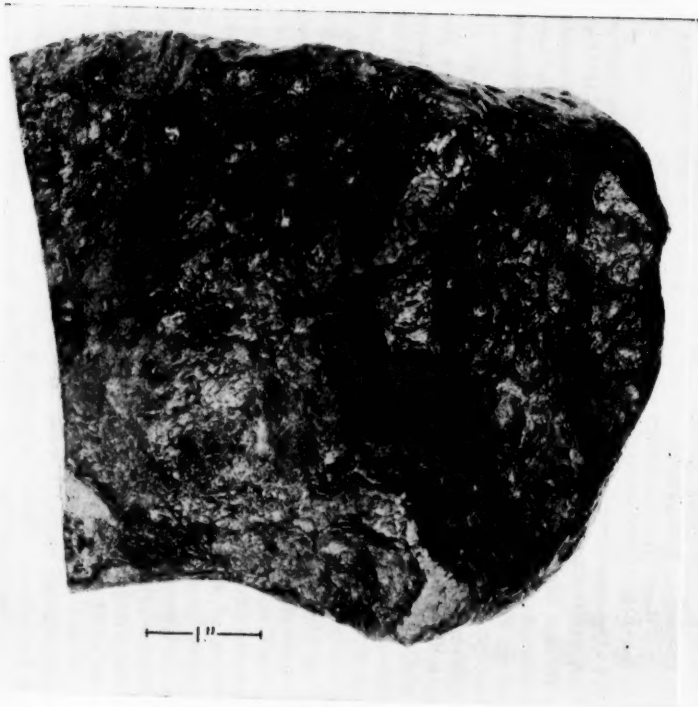


FIGURE 1. CAMPBELLSVILLE, TAYLOR COUNTY, KY.

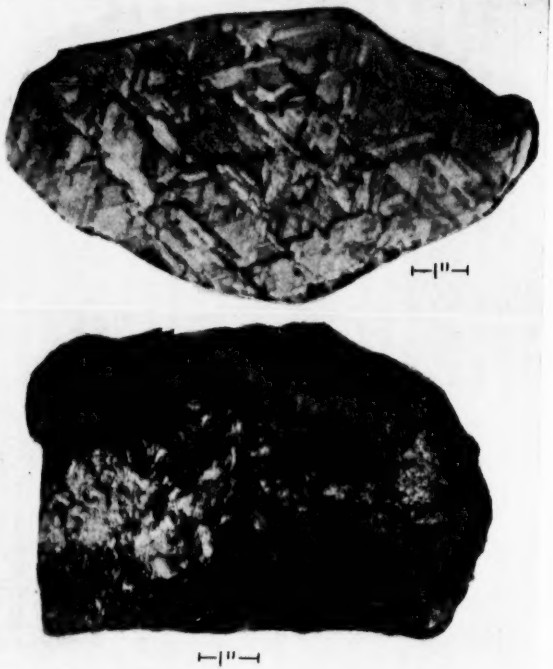


FIGURE 2 (above). CLARK COUNTY, KY.
FIGURE 3 (below). PROVIDENCE, TRIMBLE CO., KY.

should be made to determine whether or not additional fragments exist where the originals were recovered. Such examinations made elsewhere in the country have proved very fruitful, and should be undertaken here, at least on the sites where siderites are known to have fallen. The single mass of the Providence siderite, as recovered by Mr. Yeager, weighed 6.804 kg. (about 15 lbs.), had a maximum length of 17 cm., and a maximum diameter of 10 cm. Arrangements for the purchase of the meteorite were concluded on the spot, both the main mass and a smaller fragment that had been removed being secured.

Polishing of an end section and etching with 6% nitric acid, revealed the usual Widmanstätten figures characteristic of the octahedral group of siderites. As mentioned before, the octahedral crystallization was visible, even on the weathered surface of the iron. The predominant constituent is kamacite, occurring in well-defined lamellae of from slightly more than one, to 2 mm. in thickness. Structurally, the kamacite is mostly of the granular variety, but occasional lamellae showing excellent hatching were observed. Both the swollen and the grouped types of arrangement of the kamacite bands were noted on the section examined. The usual thin plates of taenite border the kamacite bands and were best shown in the earlier stages of the etching process, standing in distinct relief above the other nickel-iron alloys. Plessite is present in subordinate amounts. No nodules or plates of troilite were visible on the section examined, but staining, that developed after etching, was due probably to the presence of minor amounts of this sulphide. No schreibersite was noted in quantity, but certain small inclusions within the kamacite lamellae are thought to be this mineral.

Quantitative analysis by Dr. J. S. McHargue, of the Department of Chemistry of the University Experiment Station, gave the following results:

Fe	88.54%
Ni	10.30
Co	0.30
Cu	0.02
Mn, Ti	Trace

From the aforementioned characteristics of structure and composition, the meteorite is classed as a siderite of the coarse octahedrite (Og) variety. It is named the Providence, Trimble County, siderite, the county being included to avoid confusion with a larger town in the State, of the same name.

FIGURE 1. CAMPBELLSVILLE, TAYLOR COUNTY, KY.

FIGURE 2 (above). CLARK COUNTY, KY.
FIGURE 3 (below). PROVIDENCE, TRIMBLE CO., KY.

Some Properties of the Beenham, New Mexico, Aërolite

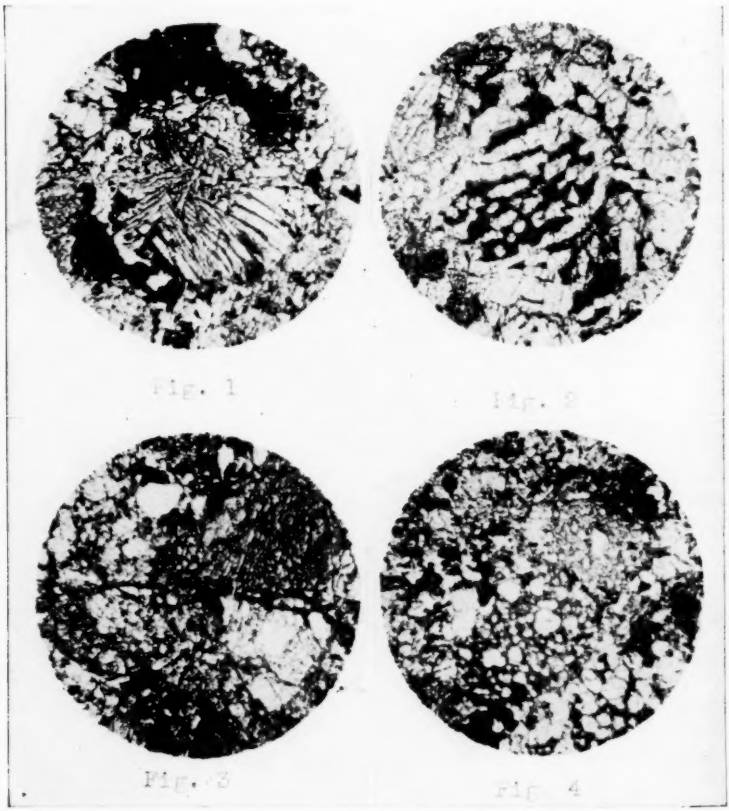
By ROBERT M. LEARD,
Departments of Geology and Astronomy, University of California, Los Angeles

ABSTRACT AND INTRODUCTION

The following description of an aërolite from Beenham, Union County, New Mexico, is offered as part of the work in a special course in meteoritics in the Department of Astronomy of the University of California, Los Angeles. Two fragments, weighing 14½ g. and 1½ g., of the aërolite, were secured, and from this material three thin sections and one polished section were prepared for investigation. Four photomicrographs were taken, and the relationships and optical properties of the various minerals were determined. The writer wishes to thank Dr. H. H. Nininger of the American Meteorite Laboratory, Denver, Colorado, for donating the material used, and Dr. Frederick C. Leonard of the Department of Astronomy of the University of California, Los Angeles, under whose guidance this study was made.

General Properties of the Aërolite

The Beenham, Union County, New Mexico, aërolite, found in 1937 (S. R. M. Provisional No. 110), is a fine, gray, veined chondrite, which, according to Brezina's classification,[1] is Cha, consisting of olivine, enstatite, nickel-iron alloy, and troilite, the metallic portion being about 15%-18% of the mass. In the metallic part, the nickel-iron and the troilite appear to be in about equal proportions. These two substances are generally in contact with each other, but both occasionally occur separately in the sections studied. However, it must be borne in mind that the sections are only about 0.001 of an inch thick, and do not show, necessarily, the true relationship in three dimensions.



Four Photomicrographs of the Beenham, New Mexico, Aërolite

Fig. 1. An enstatite chondrus partially inclosed by Ni-Fe, ×26
Fig. 2. A chondrus of olivine and enstatite, ×26
Fig. 3. A branching vein, ×26
Fig. 4. A chondrus of small olivine grains, ×26

Fig. 1 suggests that the chondri were formed before the metallic portion solidified, as the chondri are in general free from Ni-Fe or troilite except at the edges, where there is some intergrowth. This texture is suggestive of the intersertal texture found in many terrestrial rocks. The chondrus shown in Fig. 2 consists of a core of enstatite, almost completely surrounded by olivine. Hence, the olivine crystallized probably after the enstatite did. Veins (see Fig. 3) of black, opaque material (glass?) are clearly later in formation than are any of the aforesaid substances, and in the interstices between the mineral grains is a gray substance, not isotropic, having an index of refraction below that of the olivine; in some cases, this substance appears to be fibrous. From the preceding evidence, it would seem that the order of formation was enstatite, olivine, Ni-Fe and troilite, unidentified interstitial material, veins, and, lastly, limonite. The limonite has been formed evidently from the alloy, as the meteorite was exposed to terrestrial weathering.

Optical Properties of the Olivine

Particular interest was taken in the olivine portion of the meteorite. This part appears both as chondri and as distinct grains, the crystals being in many cases euhedral. There is a large variation in grain size, but within a chondrus the grains are of about the same size. Several of the chondri show the peculiar lamellar growths described by Farrington,[2] while others contain small, black, dusty grains of magnetite (or chromite?).

By oil immersions, the three indices of refraction were found to be

$$\alpha = 1.678\pm,\ \beta = 1.695\pm,\ \gamma = 1.716\pm,$$

and $2V = 85°$. These data yield a formula of 21 molecular per cent Fe_2SiO_4 and 79, Mg_2SiO_4.[3]

References

[1] Farrington, O. C.: *Meteorites*, p. 199, 1915.
[2] *Op. cit.*, ref. (1), pp. 183-4 and Fig. 58.
[3] Winchell, A. N.: *Elements of Optical Mineralogy*, **2**, Fig. 109, p. 191, 1933.

Fused Meteoritic Iron: Second Paper

By John Davis Buddhue,
99 S. Raymond Av., Pasadena, California

Abstract

Specimens of Henbury, Central Australia, and Canyon Diablo, Arizona, were fused and examined metallographically. Henbury gave a fine granular structure with probably nickel-rich grain boundaries. Canyon Diablo, containing schreibersite, gave a granular structure, except where the schreibersite produced a pearlite-like mixture. At the edges of this was a structure resembling martensite. Another specimen fused on charcoal was composed partly of grains of ferrite inclosed in cementite. The remainder showed a dendritic structure. This specimen exploded during fusion. Mention is made of other work in this field.

In my first paper on fused meteoritic iron,[1] I gave a review of the literature then known to me on this subject, and reported on the result of the fusion of a piece of the Xiquipilco (Toluca), Mexico, iron. According to Farrington, Daubrée[2] reported that Charcas, Mexico, did not show the characteristic figures after fusion, but he did not report further on the structure of the melted iron. Lacroix

used an oxy-acetylene torch to cut the Tamentit, Tuat, Morocco, iron and found that the structure was unaltered after 7 minutes. The magnetite produced was nickel-free, but droplets of inclosed metal contained 16.3% to 37.0% Ni, while the unfused metal contained only 8.11% to 8.39% Ni[3]. This result is in agreement with the experiments of Jander and Senf,[4] who found that the percentage of nickel in the oxide of the system, $FeO + Ni \rightleftarrows NiO + Fe$, is very small at 1600° C., until the nickel in the metal exceeds 50%. As I have used small samples in my experiments, and the cores were incompletely fused, this condition may be responsible for the fact that the nickel contents, especially near the surface, were probably higher than the published analyses of the various irons indicate. Stuart H. Perry has reported an interesting result of the natural fusion (and probable nickel enrichment) of the Seneca Township, Michigan, iron[5]. The particles of metal inclosed in the fusion crust showed a marked dendritic structure. He reported also that he had seen the same thing in the Wood's Mountain, North Carolina, iron.

A sample of Henbury, Central Australia, was fused in the same way as was Xiquipilco[1]. Picral (alcoholic picric acid) developed a very fine granular structure. The grain boundaries seemed to be raised and to be about one-fifth as wide as the grains themselves. Near the surface, the grains were a little larger and were separated by films of oxide. On the whole, the structure was very similar to that of Mt. Joy, Pennsylvania, shown on plate 3 of Merrill's work on the origin of metal in meteorites[6]. Nitric acid (1:8) revealed the same structure less clearly. The acid contained a trace of copper, and in some places this was deposited on the grain boundaries only. A similar reagent deposited copper on only the taenite of Canyon Diablo. This circumstance, and the fact that the boundaries were less soluble than the cores, may indicate that they were richer in nickel than the cores. Longer etching with copper-free acid produced round pits in the grain boundaries, but only rarely elsewhere. Still longer etching increased their depth, but not their diameter. This fact may indicate also a higher nickel content, as Bendicks found similar structures in invar. He ascribed them to particles of kamacite inclosed in taenite.

Two specimens of Canyon Diablo, Arizona, were fused. One specimen contained inclusions of schreibersite, which produced large local enrichments of phosphorus. These etched black with nital (alcholic nitric acid), and gray with picral. Successive short etchings with nital caused the gradual appearance of clearly marked polygonal grains except in the incompletely fused core. This core resembled heat-granulated kamacite. At the very edges of the specimen, the grains were irregular, small, and inclosed in oxide. The phosphide enrichments consisted of a pearlite-like mixture of metal and a black constituent. In one place this mixture was replaced by a group of minute dendrites resembling overlapping bird-tracks in mud. Picral had much the same effect, except that the grain boundaries were less clear. At the edges of the phosphide enrichments, a new structure appeared which resembled martensite. The needles were much larger, however, than any I have seen in photographs. Their widths ranged from 0.004 to 0.018 mm. This is not the first time that a martensitic structure has been reported in fused meteoritic iron. L. J. Spencer has reported that J. M. Robertson[7] found an indistinct type of martensitic structure in the spheres of fused metal found in the silica glass from Wabar, Arabia. This naturally fused iron formed polygonal grains with inclusions at the borders. At ×440, the picral-etched core of heat-granulated

kamacite seemed to be made up of small, irregular grains, each consisting of a differently oriented bundle of needles, averaging 0.002 mm. in width.

The second specimen of Canyon Diablo, which also may have contained some schreibersite, was inadvertently fused on a charcoal instead of an asbestos block. Heating was terminated when the specimen exploded, showering the laboratory with sparks. The cause of the explosion is unknown, but it is mentioned here because of its possible bearing on the detonation of meteorites in flight. The residue contained a number of rough-walled cavities. Ammonium persulphate developed a faint granular structure, which was intensified by nital. Polish attack showed that part of the iron was composed of grains of ferrite with thick borders of cementite. These were formed doubtless by absorption of carbon from the charcoal block. In other parts of the specimen there was a dendritic structure exactly like that appearing on plate 3 of Merrill's paper[6].

My thanks are due to Dr. G. M. Prince for his kindness in making these fusions for me in his laboratory.

References

[1] *C. S. R. M.*: *P. A.*, **45**, 275-7; **1**, No. 3, 25-7, 1937.
[2] *Comp. Rend.*, **64**, 633, 636-40, 1867.
[3] *Comp. Rend.*, **184**, 1217, 1927; **185**, 313, 1927.
[4] *Zeit. Anorg. Chem.*, **210**, 316-24, 1933.
[5] *P. A.*, **47**, 190-1, 1939.
[6] *Proc. U. S. Nat. Mus.*, **73**, Art. 21, 1938.
[7] *Min. Mag.*, **23**, 396, 1933.

The Lund, Sweden, Aërolite of 1939 April 5

The Editor takes the liberty of quoting the following paragraph from a private letter dated 1939 May 7, from our Swedish fellow, Dr. Axel Corlin of the Astronomical Observatory at Lund:

"No meteorites of the previously mentioned fireball swarm [that of 1938 May 27] have been picked up on the ground, probably because all of them fell into the Baltic Sea. But perhaps you will be interested to hear that another meteorite fell very recently near Lund and was picked up the same day, namely 1939 April 5. It weighs 3.31 kg. and is a typical chondrite. It has the form of a triangular prism, with a side of 14 cm. and a height of 7 cm. It fell at $6^h\,12^m$ G.M.T. that date and made a hole in the ground of but 35 cm. Some railroad men witnessed the fall on the spot—and many persons heard the noise far away—and the meteorite was immediately fetched by geologists from the Mineralogical Institute of the University of Lund, where it is now kept."

A more detailed account of this aërolite, by Dr. Corlin, will appear in the *C.S.R.M.* in an early issue of *P. A.*

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

Variable Stars in the Milky Way: A recent publication of the Berlin-Babelsberg Observatory contains a discussion by C. Hoffmeister on variable stars situated in the Milky Way. Seven fields have been examined by six observers and approximately 500 variables have been detected and studied. Although a few of these stars are as faint as seventeenth magnitude and some are brighter than the twelfth, the majority are between the fourteenth and fifteenth magnitudes.

Forty-six per cent of the total number are long-period variables, 18 per cent are irregular, 10 per cent are eclipsing, and 18 per cent are of short period, mainly Cepheids. Numerical comparison with the types listed in the 1939 Schneller Catalogue is of interest: long-period variables numbered 39 per cent of the whole, eclipsing variables 20 per cent, and Cepheids 21 per cent.

It is surprising how uniformly this ratio holds true in successive variable star catalogues, even as far back as the time of Argelander. His catalogue of a century ago comprised only 18 variable stars, of which 44 per cent were of long-period, 11 per cent were eclipsing stars, and 11 per cent were Cepheids. Irregular variables, such as α Herculis and α Orionis, totalled 22 per cent, as against 18 per cent in Hoffmeister's analysis, and 9 per cent in the Schneller catalogue.

Many of the stars enumerated in the Hoffmeister paper appear also in Schneller's list, although about a third are not so included. Numerous light curves, mainly of eclipsing stars and Cepheids, are given by Hoffmeister, together with the elements for many long-period variables. There are likewise copious notes, including observed dates of maxima and minima for the stars discussed.

The Ann Arbor Meeting of the A.A.V.S.O.: The week-end of May 19-21, 1939, was the occasion for the first middle-western spring meeting of the A.A.V.S.O., which was held at the University of Michigan, Ann Arbor, Michigan. As was to be expected, many members heretofore unable to attend the regular meetings were in attendance.

The sessions began on Friday evening with a scheduled lecture on "Temporary Stars" by Professor Dean B. McLaughlin, a subject of timely interest to amateur and professional alike. Following the lecture, many members availed themselves of the opportunity of visiting the well-equipped private observatory of Mr. C. B. Carpenter at nearby Wayne, while others made good use of the 10-inch refractor at Ann Arbor.

The Saturday morning session convened at 10:30 o'clock, with Director H. D. Curtis officially welcoming the Association to the University of Michigan Observatory and its several stations. This session was devoted mainly to the presentation of papers and their discussion. W. S. Houston of Milwaukee described in detail "An Amateur Photometer," patterned somewhat after the instrument introduced to members at Harvard some years ago, but which, for some unexplained reason, has not been much used by observers. He called attention especially to the various types of wedges available for more accurate determination of stellar magnitudes.

Clinton B. Ford, a graduate student at Ann Arbor and for many years an active A.A.V.S.O. observer, presented a comprehensive paper, "A Statistical Study of A.A.V.S.O. Observations in Harvard Annals 104." He took as the basic material for his comparison the observations made by several observers, on the same star, on the same night. His results for the personal equation, derived from nearly 6,000 observations of fifty stars by some 150 different observers, were truly revealing. In general, he found that a definite correlation exists between the sizes of the statistical errors of observation and the increasingly greater redness of the stars—a correlation long suspected, but now quantitatively demonstrated.

Following the "shooting" of many group-photographs, both "stills" and "movies," at the close of the morning session, members and their friends lunched together in the Russian Room of the League Building.

The first part of the afternoon session was devoted to regular business affairs, with the reading of the minutes of the October, 1938, Harvard meeting, reports of the Chart Committee and Chart Curator, and announcements of newly elected members and new committees. Mr. Roy A. Seely, of New York, was appointed the new chairman of the important Nova Search Committee, *vice* Mr. L. E. Armfield, resigned. The presentation of additional papers then proceeded. "Variable Star Problems for the Professional," by the Recorder, outlined some of the questions which, with the wealth of material already accumulated and yet to be obtained by A.A.V.S.O. members and others, will soon have an adequate observational basis for theoretical study and discussion by professional astronomers. The Recorder showed many slides illustrating the progress of variable star work and some of its still-unsolved problems.

Then followed an illustrated talk by Mr. E. A. Halbach, of the Milwaukee Astronomical Society, on the erection of the society's observatory, together with some remarkable photographs of aurorae taken in coöperation with the National Geographic Society-Cornell Auroral Survey under the direction of Dr. E. W. Gartlein of Cornell. Mr. Fred. E. Ellis, of Portland, Oregon, and Cambridge, Massachusetts, concluded the afternoon meeting with a paper on "The Light Curve of Z Camelopardalis" in which he traced the history and discussed the vagaries of this interesting star, and its resemblances to, as well as differences from, the SS Cygni-type variables. His large scale plotting of the light variations of the star evoked much favorable comment.

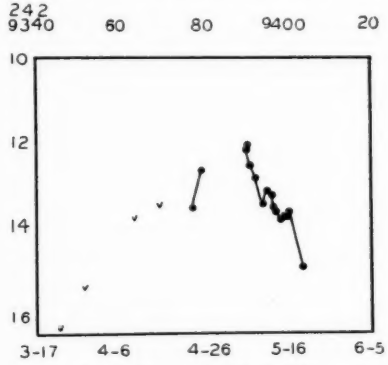
Following inspection of the main observatory where Dr. Curtis and his staff demonstrated the equipment, recess was held until the banquet hour at the Michigan Union, when Professor W. Carl Rufus acted as toastmaster. After the dinner, members repaired to Angell Hall to witness more "movies" as shown by Messrs. Halbach and Carpenter.

On Sunday morning an excursion to Lake Angelus to inspect the McMath-Hulburt station of the Observatory concluded the meetings. Here were shown movie-reels of some of the latest results in the work on solar prominences.

The annual meeting of the Association is scheduled to be held at the Harvard Observatory during the week-end of October 13-15, 1939.

Supernova in N.G.C. 4621: The recent discovery by Dr. Zwicky of a fifteenth magnitude supernova in N.G.C. 4621, one of the members of the Virgo cluster of galaxies, prompted the search among Harvard plates for additional observations. Dr. Hoffleit, according to *Harvard Announcement Card* No. 487, has found a number of plates on which the star appears prior to the date of discovery (May 19, 1939). The accompanying graph of her observations indicates a probable date of

maximum on May 1, 1939, when the star attained at least magnitude 11.0, possibly even brighter. Dr. Minkowski's conclusion, drawn from an examination of a spectrum secured on May 20, that the star at that time was a supernova about



SUPER-NOVA IN N.G.C. 4621

three weeks past maximum, is thus remarkably well confirmed.

The two Harvard observations obtained on the increase to maximum, April 23 and 25, show a moderately slow rise for the nova, especially near maximum phase. Humason's estimate of an apparent radial velocity of +500 km/sec for N.G.C. 4621 would indicate a probable distance of 1500± kiloparsecs. The nova was at least fainter than magnitude 16.5 before its outburst. How a nova can attain a brightness greater than the intrinsic light of the nebula in which it appears, is truly phenomenal!

Two Interesting Variable Stars: Dr. L. Jacchia, now carrying on research work at Harvard Observatory, reports on two variables which have occupied his attention as a visual observer during recent years. The more interesting is AH Herculis, 164025, discovered by Ceraski in 1923, who suspected it to be of long period, with a photographic range from magnitude 10.5 to <13.0. Esch observed the star in 1931 and found some rapid variations. Jacchia's observations of 1936-37 indicate a fairly regular variation between magnitudes 11.2 and 14.1, with a period of 19.62 days, and a perfectly smooth and symmetrical light curve. The short period assigned might suggest that the star belongs to the Cepheid type, but here the variation in light, nearly three magnitudes, is far too great, and the rise to maximum too slow for one to designate it as of this class. Jacchia suggests that the star may more properly be related to the Z Camelopardalis class, since we do find another star of the class—CN Orionis—which sometimes shows, for several months in succession, regular sinusoidal variations within similar periods of time and extent of variation.

YZ Cephei, 221456, discovered by Ross in 1925 and confirmed by Hoffmeister in 1929, was suspected by the latter to be of the eclipsing type, with a range in magnitude from 11.5 to 13.0. Jacchia's visual observations of 1931-37 show that the star remains at nearly constant maximum brightness, 12.0, for a long time and then suddenly decreases to minimum at very irregular intervals and to varying depths, thus excluding the possibility that the star is an eclipsing variable. The

light curve has many similarities to that of T Orionis, which is involved in the Great Orion Nebula; and these stars, with others such as XY Persei and R and S Coronae Australis, should doubtless be classed as extrinsic variables, associated with nebulosity.

Observers and Observations, May-June, 1939

Name	May Var.	May Obs.	June Var.	June Obs.	Name	May Var.	May Obs.	June Var.	June Obs.
Adamopoulos	4	4	..	..	Keuziak	2	2	2	2
Ahnert	45	299	..	..	Kirkpatrick	12	16	..	..
Albrecht	89	177	6	7	de Kock	65	237	59	220
Baldwin	69	185	60	153	Kozawa	20	44	..	..
Ball, A. R.	13	13	17	19	Lange	4	9	..	..
Ball, J.	..	..	17	20	Loreta	162	514	155	465
Bappu	..	..	17	42	Mages	61	116	48	89
Blunck	21	25	21	21	Maupomé	10	10	24	24
Bouton	47	70	48	55	McLeod	30	49	..	..
Brocchi	..	..	30	41	Meek	81	483	93	300
Buckstaff	10	41	9	35	Mitchell	..	..	31	35
Callum	37	49	24	39	Needham	14	15	3	3
Cameron	6	6	..	..	Palo	6	19	14	42
Campbell	..	..	2	2	Parker	23	34	13	13
Carpenter	16	17	..	..	Peltier	55	103	49	108
Cousins	30	102	..	..	Prinslow	13	13	7	7
Dafter	9	23	4	10	Purdy	5	5	11	17
Diedrich	2	2	8	10	Riegelman	..	..	16	19
Economou	13	14	9	10	Rosebrugh	15	25	9	52
Ellis	..	..	2	2	de Roy	13	67	14	68
Ensor	55	112	..	..	Russell	15	21	19	33
Escalante	23	28	33	33	Ryder	7	10	6	6
Farnsworth	8	9	..	..	Schmid	..	..	27	27
Fernald	52	87	52	134	Schoenke	8	8	27	35
Focas	29	66	..	..	Seely	5	6	..	..
Ford	15	15	34	39	Sill	32	33	8	8
Franklin	15	22	16	23	Smith, F. P.	18	28	18	27
Gomi	..	..	5	30	Smith, J. R.	15	15	18	18
Gregory	34	57	103	154	Stuart	..	..	11	15
Halbach	80	81	97	125	Topham	36	41	7	7
Hartmann	113	174	113	163	Treadwell	8	8	13	23
Hiett	18	31	20	30	Webb	30	30	15	16
Hildom	22	63	26	48	Weber	42	42	19	19
Holt	89	227	95	232	Whittier	2	2	3	4
Houghton	82	249	84	125	Williams	9	24	..	..
Howarth	18	19	18	19	Yamada	..	..	5	36
Jones	68	200	70	175	Yamasaki	21	21	18	18
Kearons	58	109	50	93					
Kelly	12	23	15	15			4597		3730

July 1, 1939.

Comet Notes

By G. VAN BIESBROECK

The list of comets visible this year is going to be long. When the last notes were written, five of them had been announced since January 1. Two more have been added since. Both, however, were expected periodic comets.

Comet 1939 *f* (Periodic Schwassmann-Wachmann 1925 II). This comet was found photographically at Johannesburg (South Africa) by Jackson on a

plate taken June 12 as a diffuse object of magnitude 13. The announcement was not made until June 16 and in the meantime the object had been independently recovered on plates taken June 14 by the writer. The object is poorly situated for northern observers, being at a declination of —33°. The measures indicated a small correction to the ephemeris that had been published by J. Behrens. With this information, earlier plates were investigated and the faint trace of this object was found on plates exposed May 17 and 18 by C. Seifert and J. Greenstein at the 82-inch reflector of the McDonald Observatory. At that time the magnitude was only 17 and the image nearly starlike except for a very dim coma around the nucleus. This is the periodic comet that has shown such exceptional and rapid changes in brightness ever since it was discovered in 1927. Its nearly circular orbit brings it in opposition every year somewhat like an asteroid and it has been well followed since it was first found. But sometimes in a few days there have been changes of several magnitudes without appreciable changes in distance, and again this year we have already indications of the recurrence of such changes. The comet having a period of sixteen years, it will have been followed all the way around its orbit in a couple of years.

The next expected periodic comet was first recorded photographically with the Crossley reflector of the Lick Observatory by H. Jeffers. It is COMET BROOKS II which will now also be designated as 1939 *g*. It appeared as an extremely faint nebulosity of magnitude 17 near the predicted position. It is visible in the early morning hours. We can expect this object to brighten up but it will remain quite faint and large telescopes will be required to see it even at its brightest in October. It will be nearest to the sun on September 16, less than a day later than was predicted.

The comets previously found this year are no longer in reach except PERIODIC COMET KOPFF which is, however, not brighter than a fourteenth magnitude star. COMET PONS-WINNECKE has now moved to the southern hemisphere.

The Editor received a letter from Mr. Lewis V. Smith of Edmonton (Canada), one of the independent discoverers of COMET 1939 *d*, mentioning the fact that his discovery was made one day earlier than we stated on p. 332. The time used by the writer is always the Universal Time (U.T.) which begins at midnight Greenwich. The Russian observers Jurloff and Achmaroff saw the comet first on the evening of April 15, the time being about 15.8 since they were situated east of the Greenwich meridian. Mr. Smith and his friends being located in Western Canada (Alberta) mentions that his discovery was made at 9:30 P.M. on Saturday, April 15; the time is therefore April 16.2 in U.T. Hence the observation was made on the same night that the Siberian observers first glimpsed the newcomer. The change in date is therefore a question of longitude and means in reality only a few hours difference instead of a day.

There are three more periodic comets expected in the coming month: COMET BORRELLY, which passed perihelion at the end of June, is very unfavorably situated but may perhaps be observed in the morning sky this fall. It will, however, be very faint. Wolf's second periodic comet should now be in reach of larger telescopes also in the morning sky but, owing to large perturbations by Jupiter since the 1925 apparition and to the fact that it was missed at its previous return, there is a great deal of uncertainty in the predicted position.

Tuttle's periodic comet is also expected in the latter part of the night. In

August it will cross the constellation of Auriga, but also in this case the object will be too faint for ordinary telescopes.

Williams Bay, Wisconsin, July 19, 1939

Notes from Amateurs

Ragnarok

About 1882 Ignatius Donnelly wrote two books: "Atlantis" and "Ragnarok." After nearly 60 years these books are still extremely interesting for they were based on extensive and exhaustive research. "Ragnarok" is specially rich in extended quotations from world-wide ancient legends, seemingly referring to comets or destructive meteoric showers. Those who are interested in meteorites and in geology will find the reading of "Ragnarok" well worth while. The object of the book was to show that the deposits of clay, gravel, and boulders we know as drift was due to the collision of debris from comets or other meteoric matter with certain parts of the Earth's surface at a time previous to the ice age; that the ice and floods were due to the increase of moisture in the air occasioned by the great heat caused by the collisions; that the period of heat and storminess was followed by a period of coldness, cloudiness and final clearing of the skies so that climate became much as it is today.

I do not think Donnelly proved his case but "Ragnarok" is rich in legend and the statement of facts are well worth attention today when we are studying meteorites more carefully than ever before. These books are available in most libraries and in some second hand bookstores.

W. E. Duckwall.

P. O. Box 441, Hillsboro, Ohio.

National Convention of Amateur Astronomers

As the time draws closer for the national exhibition of amateur astronomical doings and equipment on the first floor, Roosevelt Memorial Wing of American Museum of Natural History, sponsored by the Amateur Astronomers Association from July 30 to August 20, plans are also near completion for a most unusual two-day convention to end the exhibition; from a trip around the New York World's Fair conducted by its science director, Dr. Gerald Wendt, to a rocket trip to the moon and the end of the world at the Hayden Planetarium; a lecture by one of the world's greatest astronomers, and many other things. It will be an opportunity for amateur star-gazers from all over the country to gather in New York City, to meet and discuss mutual problems of how societies may communicate with each other for mutual interests, information, etc. It is planned during the convention to form a committee of representatives from all societies present, for intercommunication at any time and possibly another such convention some time in the future. Following are the events planned for August 19 and 20:

The American Museum opens on the 19th at 10:00 A.M. to allow an hour for reviewing the exhibition before the opening session in Lecture Hall, Roosevelt Memorial. At 11:00 Dr. Clement Brainin, President of the A. A. A., will start the proceedings, with Dr. Clyde Fisher, Curator of Astronomy at the Museum and Director of the Hayden Planetarium, delivering the opening address of wel-

come. It is also hoped to have present that veteran comet seeker and discoverer of Delphos, Ohio, Mr. Leslie C. Peltier, to deliver an address.

After luncheon in Flying Bird Hall the group will leave for the World's Fair at 1:45 for the General and Public Session there, probably in the Special Events Building, starting at 3:00 P.M. To add to the festiveness of the occasion the day has been designated as Amateur Astronomers' Day, and Dr. Wendt will deliver the address of welcome and introduction. Dr. James Stokley, Director of the Buhl Planetarium recently opened in Pittsburgh will also be present on the platform. One of the world's foremost astronomers, the renowned Dr. Harlow Shapley, Director of the Harvard College Observatory, is to present a special lecture for the occasion. It will be an unusual privilege, indeed, to hear Dr. Shapley, upon whose shoulders have been heaped many honors for his genius and ingenuity in the science of the stars by his appreciative fellow scientists throughout the world.

A climax of the afternoon will be reached at 4:00 with a special tour of the Fair conducted by Dr. Wendt. The day's activities will be culminated in the evening at 9:00 with telescopes of amateur astronomers ready for use at various Fair locations and elsewhere in the city.

The second day of the convention, Sunday, August 20, will open at 10:30 A.M. at the Hayden Planetarium with a preliminary Copernican lecture, followed at 11:00 with an unusual, Special Planetarium Demonstration of the famed Zeiss projector. Dinner at the Planetarium Restaurant of the Hotel Standish Hall at 1:15, the big convention dinner of the affair, with introduction of various representatives of societies throughout the country.

The final general meeting will be held at 3:00 in the afternoon to form an Organization Committee from delegates present, and plan a program of future events. Then those present will break up into sectional meetings, according to the particular branch of astronomical interest (telescope making, photography, observing, etc.) and the conclusion of these meetings will draw the convention to a close.

LEWIS L. DOOLITTLE, Publicity Chairman.

July 1, 1939.

The New Haven Amateur Astronomical Society

The last meeting of the season of the New Haven Amateur Astronomical Society was held in the Yale Observatory Lecture Room on June 3. Miss Dorothy Johnstone (one of our group) addressed the society on the "Astronomical Transit" and said in part that the transit was an instrument devised to record the instant when a star in its diurnal motion crosses the meridian. The great circles of the celestial sphere which pass through the poles and which are therefore perpendicular to the celestial equator are called hour circles. Each star has its own hour circle, which apparently moves with it.

The hour angle of a star is the angle at the pole between the celestial meridian and the hour circle of the star. The right ascension of a star is the angle made at the celestial pole between the hour circle of the star and the hour circle which passes through the vernal equinox.

In the focus of the object glass and eyepiece of the transit is a system of wires called the reticle. This consists either of spider threads attached to a frame or of fine lines ruled on thin glass. An odd number of wires, usually five, seven, or eleven, are placed parallel to the collimation plane over which the time of transit of a star's image is observed. The middle wire affords a visible image of a part

of the invisible meridian and the sidereal time when a star crosses that wire is therefore the star's right ascension. The observer by pressing a button at the instant the star crosses the center wire records the exact split second on an electrically controlled chronograph which records to a hundredth of a second and can later be examined at the observer's leisure.

Following this instructive talk the Program Committee repeated a broadcast recently sent out from station WELI, put on by three of our members, Mrs. Partridge, Mrs. Rademacher, and Mr. Knapp. The subject was "The Appreciation of Astronomy." Mr. Glowacki was the announcer. The speakers and announcer were in a distant room in the Observatory and the group listened to a radio in the Lecture Room. The various members of our society have broadcast over network stations a total of five times and have been the recipients of many complimentary remarks.

F. B. BURNHAM.

June 10, 1939.

Amateur Astronomical Society of Los Angeles

The Amateur Astronomical Society of Los Angeles held its regular monthly meeting on the evening of Thursday, June 8, 1939, at 2606 West 8th St., Los Angeles. After the meeting had been called to order by the President, Mr. J. Foster Nelson, the minutes of the previous meeting were read, and other routine business was transacted. The speaker of the evening, Professor Alfred H. Joy of the Mount Wilson Observatory, was then introduced.

Professor Joy had chosen for his subject "The Rotation of the Galaxy," a matter upon which he has done considerable research. In the solar system, and in similar organizations, such as the rings of Saturn, where a number of bodies move under the attraction of a central mass, it is found that those moving in the smaller orbits travel the most rapidly, and those in the larger orbits move more slowly. Hence it is reasonable to assume that, in the rotation of our galactic system upon its axis, the stars participating in this motion behave in a similar manner; that is, those nearer the center have shorter periods of revolution. There is obviously considerable difficulty in investigating the rotation of such a body, especially as we are located within it. The rotational motion is not apparent when we deal with ordinary stars, which usually are of rather low luminosity, and have high individual velocities. It is therefore necessary to use for the rotational study some class of stars which are of high luminosity, so that they can be seen at great distances, and which do not have high individual velocities, so that the rotational term can be distinguished easily. These requirements are met admirably by the Cepheid variables—stars of high luminosity which are concentrated along the galactic plane.

From a recent study of the radial velocities of 156 of these Cepheids, with observations made principally with the 100-inch Mount Wilson reflector, Professor Joy has obtained a period of 207 million years for the revolution of the sun about the center of the system, which lies behind heavy obscuring clouds in the direction of the constellation Sagittarius, about 33,000 light years distant. The orbital velocity of the sun is about 180 miles per second.

The thanks of the audience were extended to Professor Joy for his clear and lucid presentation of a rather involved subject. Announcement was made of three excursions to be held this summer by the Socity. The first, a picnic with the Citrus Belt Amateur Astronomers, at Riverside, Calif., on June 17; an observing party at the home of a member in San Fernando Valley on June 24; and our an-

nual Mount Wilson trip on July 15. On the latter, we will be allowed to inspect the 100-inch reflector and the 150-foot solar tower in the afternoon, and in the evening, the 60-inch reflector will be available for observations until about 11:00 o'clock. There will also be talks by several distinguished astronomers.

June 17, 1939. GEORGE HERBIG, Secretary.

The Seventh Year of the Rhode Island Skyscrapers

The annual election and business meeting of Skyscrapers, Inc., amateur astronomical society of Rhode Island, was held in Room 1, Wilson Hall, Brown University, Providence, R. I., on June 22, 1938. The following officers were elected: President, Donald S. Reed; First Vice-President, Archibald C. Matteson; Second Vice-President, Samuel Holman; Secretary-Treasurer, John L. Euart.

The program of the seventh year was as follows:

1938 July 26. Outdoor meeting at the home of Mr. and Mrs. Frank P. Sherman, Johnston, R. I. Members saw a brilliant fireball, one of the largest seen in this vicinity in recent years.

August 18. Outdoor meeting at the Skyscrapers own observatory, the Seagrave Memorial Observatory in North Scituate, R. I.

September 8. Outdoor meeting at Seagrave Memorial Observatory in North Scituate, R. I.

October 12. Professor Charles W. Brown of Brown University spoke on "Cyclones and Hurricanes." His subject was most appropriate because New England was just then recovering from the disastrous hurricane of September 21, 1938.

November 2. Dr. Alice H. Farnsworth, Director of Astronomy at Mount Holyoke College in South Hadley, Massachusetts, spoke on "Shadows, Astronomical and Otherwise."

December 7. Mr. Ernest R. Hager of the Skyscrapers gave a talk on his recent trip to the West and Southwest. His talk was illustrated by excellent color photographs. He also exhibited several articles which he had brought back from the West.

1939 January 4. Mr. Daniel Norman of Harvard College Observatory in Cambridge, Massachusetts, spoke on "The History of Astronomical Photography."

February 8. Miss Wilhelmina Null read a paper on "The Astronomical Work of Sir William Herschel"; Mr. William J. Gardner spoke on Herschel as a telescope maker; and Miss Maribelle Cormack dwelt on the human side of Herschel. Her talk was taken mostly from the diary kept by Herschel's sister Caroline and gave a truly human insight into the difficulties besetting this courageous and untiring woman.

March 10. Dr. Charles H. Smiley spoke on Amateurs in Astronomy. The three amateurs selected by Dr. Smiley of Brown University for discussion were Heinrich S. Schwabe, William Lassell, and Percival Lowell.

April 19. Professor Clarence H. Graham of Brown University lectured on "The Astronomer's Eyes." His talk was illustrated by some interesting practical demonstrations.

May 3. The seventh annual dinner of the Society was held at Faunce House, Brown University. Following the dinner about 100 members and guests of Skyscrapers, Inc., heard Dr. Donald H. Menzel of Harvard College Observatory in Cambridge, Massachusetts, lecture on "The Mysteries of the Sun."

Each month during the year the Society held open night at Seagrave Observatory in North Scituate, R. I., and members and guests were eager to take this opportunity of looking through the 8-inch refractor. Members were the guests of Dr. Smiley of Brown University during the lunar eclipse on November 7, 1938. Several of the Skyscrapers journeyed out to Seagrave Observatory and succeeded

in taking several excellent color photographs of the Moon. Mr. Frederick W. Hoffman of the Society exhibited these color photographs at the annual meeting in New York City of the American Astronomical Society in December, 1938, and received some very favorable comment in the *New York Times*.

Dr. Smiley of Brown donated seventy astronomical slides to the Society and members assisted in securing funds necessary to purchase a painting of the 1937 eclipse in Peru. This painting was executed by a Peruvian lady who had never seen an eclipse before.

President Donald S. Reed was able to announce that through the generosity of an anonymous donor the Seagrave Observatory had been wired for electric service.

In addition the various sections of the Society were active in making telescopes, observing meteor showers and variable stars, studying constellations, photographing star fields, and computing orbits and astronomical tables.

The Mathematical section did some very fine work in computing the orbit of Hassel's comet under the supervision of Mr. Hoffman.

June 5, 1939. JOHN L. EUART, Secretary-Treasurer.

Communications and Comments

Under this heading we shall publish from time to time such material as does not properly fall under any of the established headings of this journal. Here, too, may be found, when occasion arises, articles which the editor may not be willing to give sanction to but which, nevertheless, may be provocative of thought along new lines.

Light and Quantum Effects

ABSTRACT

1. It will be shown that taking Planck's constant h as unit of radiation, the energy emitted by one electron vibration, makes possible a simple theory which explains most of the facts of radiation under the classical laws of physics.

2. A quantum, defined as h multiplied by frequency, is not a natural unit since frequency is a number per second, which means that it must require a second for the emission of a quantum of radiation. A quantum must be a number of h units per second.

3. This permits a return to the older and simpler theory in which light is emitted by electrons oscillating at the frequency radiated.

4. An ether medium is not needed if it is assumed that electrons have electrostatic fields which act at a distance like gravitation. It is shown that when the energy of electrostatic fields is emitted at the rate of many trillions of pulses per second they are thus amplified sufficiently to account for the energy of light. The energy emitted equals h multiplied by frequency.

5. Light is composed of units of energy which do not weaken with distance because they travel in a straight line without an expanding wavefront; and because light is energy which is never destroyed but only changed to other forms by encountering electrons capable of oscillating in resonance. Thus light is always emitted and absorbed in whole units.

In view of the unsatisfactory nature of the present theory of radiation, it is believed that there must be some unknown factor or error in the fundamental premises on which the quantum theory is founded.

The quantum theory was evolved from Planck's discovery of a constant in experiments on black-body radiation, this constant (h) was later found to appear in other experiments, but has been continued to be regarded as an abstract constant. This seems to be the fundamental error, the cause of all the difficulty in understanding radiation, since it will be shown that a single change in which Planck's h is taken as a unit of energy makes possible a simple theory which brings the complex facts of radiation under the classical laws of physics.

The quantum has been given a significance it doesn't have. It is defined as the energy of Planck's constant multiplied by the frequency in vibrations *per second.* The artificial nature of the quantum results from the fact that it is a number of units *per second,* since frequency is a number per second. The time factor is usually overlooked, but a quantum cannot be an indivisible unit if an electron must act for a whole second to emit a quantum of radiation.

The quantum does not exist as a whole unit, it is merely a convenient means of expressing the energy of various frequencies in terms of energy per second, a fact not made evident by experiments which are all of a statistical nature.

Since a quantum is always a number of Planck units per second the *planck* must be the invariable unit of radiation, the energy emitted by one electron vibration or oscillation.

This permits a return to the older and more satisfactory theory according to which radiation is emitted by electrons oscillating at the frequency radiated, each vibration emitting a single wave-pulse or planck, and many trillion are emitted per second to make a quantum.

Radio waves are also emitted by oscillating electrons, but differ in that each wave is the result of a great number of electrons acting in unison, hence the energy of a radio wave depends on both the amplitude, or number of electrons, and the frequency. Since light waves are emitted by individual electrons the amplitude of the wave is not variable. Each electron vibration seems to emit a uniform unit of energy, a planck. The only variable factor of a light wave is the frequency which is probably determined by the distance of the electron jump. When more energy is available to cause electron vibration they may oscillate at a higher frequency or more electrons may be made to oscillate. The only amplitude factor of a light ray is the number of wave-trains.

The theory thus far applies to the emission of light, in planck units which are all the same size, but the greatest problem has been the fact that light is always found to be absorbed in units of the same size even when coming from a great distance. This makes necessary an explanation of the mechanism by which light is propagated through space.

The failure of all attempts to find evidence of any ether medium in which electromagnetic waves could exist is still a difficulty, even though the theory of relativity manages to avoid the problem. But on the other hand light waves are known to be pulsations of electrostatic and magnetic fields which might be supposed to act at a distance without any ether medium.

An electrostatic field is a simple force of attraction said to extend to infinity like the force of gravity. It has not been thought that gravity needs an ether medium, although any variation in its force of attraction would be transmitted to all bodies in its field, and a rapid pulsation in such a force would transmit energy to other bodies having the effect of waves on other bodies. In the same way an

electrostatic field may act as an elastic medium through which stresses are propagated into space in the form of electric waves and no ether medium should be needed.

Stationary electrons and charged bodies are known to have electrostatic fields extending to surrounding bodies on which they exert an attractive force and also induce charges of opposite polarity. Vibration or a variation of the electric charge on a body is known to cause a variation in its surrounding field, and such a rapidly changing field should be propagated away in the form of wave-trains, thus transmitted energy to distant bodies, in accordance with the principle of electric induction.

A static field exerts only an attractive force, but a changing electric field exerts also a magnetic force tending to move electrons to one side, therefore electromagnetic waves are said to be transverse to the direction of propagation, although such waves may have no actual existence except when they encounter electrons, or other particles.

Electrostatic fields have not been considered as the actual medium through which light waves are propagated on account of the extreme weakness of such fields at any distance. A stationary electron has a field which is practically indetectable; yet it is the energy of vibrating electrons which is visible as light sometimes after traveling many years through space. This has always been the deepest part of the mystery of light, yet there seems to be a simple solution which makes the entire theory acceptable.

A single jump of an electron will emit a wave-pulse with energy equal to its acceleration, but when the number of these pulses runs up to about 760 million million per second, which is the frequency of violet light, it is evident that an oscillating electron can emit a wave-train of energy many trillions of times greater than that of its static field. The energy emitted increases with the frequency since the energy per second is that of each pulse multiplied by the number of pulses. Hence the energy of light quanta increases with the frequency.

Radio transmission is also much more efficient at high frequencies, the radio amateurs were the first to discover the fact that the effective range of their transmitters depended more on the frequency used than on the power output.

Radio waves grow weaker with distance but experiments have shown that light is emitted only in units which do not weaken with distance as they should in accordance with the theory of an expanding wave-front. This does not mean that light waves must have some kind of a corpuscular nature, it only shows that light must be propagated in straight lines without an expanding wave-front.

A single vibrating electron emits energy at a certain rate which is absorbed at some other point at the same rate showing that single electrons cannot radiate energy in more than one direction at a time. Electrons may have fields consisting of a single line of force like a Faraday line, or else their oscillations radiate only in a single direction. These Faraday lines can be said to act as an elastic medium along which the electrostatic waves are propagated as variations in tension; and the transverse magnetic waves travel like undulations on a stretched wire, without spreading and without friction.

This part of the theory is not new, Faraday himself had the idea that light traveled along his lines of force, and references have been found to a further development of this theory by Sir J. J. Thomson (*Proc. Camb. Phil. Soc.*, 1908, **14**, 421) and others (N. R. Campbell, "Modern Electrical Theory," 1913). Thomson held that "Light travels in transverse vibrations along tensional lines of electric force in the ether (Faraday tubes), and the light energy is therefore concentrated

in pulses along the wave front."

Light does not curve or extend only to other bodies as electric lines of force are supposed to, electric fields are only static forces, while electric waves are kinetic energy in motion through space; and since energy has been found to have momentum and inertia it should move through space like matter, in straight lines unless interfered with. Light waves may start out as tensional variations in Faraday lines, but their momentum causes them to continue in straight lines like material particles.

Since energy can not be destroyed, a wave-train can only be stopped by a substance which will absorb its energy, and in order to do this the substance must have free electrons capable of oscillating in resonance with the wave, so that the energy of the wave is changed into some other form. This accounts for the fact that light can only be absorbed in whole units, or may be reflected, or transmitted through various substances.

A light ray consists of many parallel wave-trains with dimensions in space equal to their wave-length, and as close together as the emitting electrons until the ray as a whole becomes weaker with distance as the individual wave-trains diverge and become farther apart; but the energy of each wave-pulse is conserved as a unit since it travels without spreading and without friction and cannot be partially absorbed.

Thus in accordance with the principle of the conservation of matter and energy a light unit may travel through space indefinitely.

The only difference between a strong and a weak ray of light is the number of parallel wave-trains, thus a weak ray of light will cause the emission of electrons from a photo-electric surface having the same energy as a strong ray of the same frequency.

The new quantum theory of light cannot account for interference in the same way as the old wave theory if the width of the waves is the same as their wave-length, and they therefore cannot pass through two slits at the same time. This difficulty seems to be eliminated by a nearly forgotten theory originated to show that diffraction gratings can manufacture the colors of a spectrum and do not select already existing colors ("New Conception of Matter," by C. G. Darwin, p. 120).

In Young's experiment interference causes light from two slits to form bands on a screen where the waves from each slit arrive a whole wave-length behind those of the other slit. This can be regarded as being due to the difference in the distance between the two slits and the different parts of the screen. The rays which are bent most by diffraction travel the greatest distance to reach the screen, and light from one slit arrives a little later at the screen at any place except directly opposite its own slit. In places where the light from one slit arrives a half wave-length behind that of another there are dark places due to interference. Thus the same light ray need not pass through two or more slits at the same time to produce interference or spectrum colors.

C. F. Bugbee.

318 Haight Street, San Francisco, California, April 30, 1938.

General Notes

Sir Frank Dyson, Astronomer Royal from 1910 to 1933, died on May 25, 1939. Further reference to his important astronomical work will be made in a later issue of this periodical.

Dr. David Todd, emeritus professor of astronomy and navigation and director of the observatory of Amherst College, died on June 1. He was eighty-four years old. (*Science,* June 9, 1939.)

Reverend Father Luis Rodés, S. J., director of the Observatorio del Ebro, Tortosa, Spain, died on June 8, at the age of fifty-six, in the Jesuit College in Barcelona. Father J. Stein, of the Specola Vaticana, who transmitted this information to Dr. Harlow Shapley, enclosed a copy of a letter to him from Father Rodés, very likely the last letter written by him. The translation of it follows. It is very evident that much is written between the lines. "I want to write you just two lines with my own hand even though I write with great difficulty because of internal hemorrhages that have greatly affected my retina; of the general state in which I was left by the inappropriate alimentary régime of these past times, I am improving little by little. I am under treatment here in Barcelona and I have not yet returned to the Observatory; I have not the physical nor moral strength for that, at least now. I have nothing to add to what I told Your Reverence during our stay in Stockholm last summer. The instruments have been kept in the Castle of Perclada, near Figueras, with consequent damage. Fathers de Rafael and Romaña are working actively in the reorganization of the Observatory. The second edition of 'El Firmamento' is ready now. It came out very well. Thanks to God."

American Astronomical Society Meeting

The sixty-second meeting of the American Astronomical Society is scheduled to be held in Berkeley, California, August 7-9, 1939. In addition to the usual sessions, two other events are planned for Southern California. On August 11 an excursion will be made from Pasadena to Palomar Mountain during the day and to the Griffith Observatory in the evening. On August 12 visits to the shops of the California Institute, where the 200-inch mirror is under construction, and to the offices of the Mount Wilson Observatory in Pasadena will be made during the day, and in the evening a trip to the Mount Wilson Observatory. This meeting therefore promises to be one of unusual interest.

Cosmic Distances

Most persons, except those who have given considerable thought to astronomical matters, are greatly impressed with, for example, the large number of miles which represents the distance from the earth to the sun. And when the light-year is explained and they are told that the nearest star is more than four light-years distant, most persons will not even attempt to comprehend the statement. That such distances are relatively insignificant as cosmic distances is clearly indicated by the following paragraphs by Sir Arthur S. Eddington in commenting upon the work of Sir William Herschel.

"I have described how Herschel anticipated a great deal of our modern knowledge of the structure of the heavens. Let me conclude by telling you something that Herschel did not know. How far off is the most distant nebula with which we can communicate? By 'communicate' I mean send a radio message *and get a reply back.* We may have to wait a few hundred million years for the reply, but we do not mind that. And, of course, I ignore trifling obstacles like Heaviside layers, or the possibility that the inhabitants, if any, of the nebula may be too stupid to receive and reply to our message. I had better first give the answer. We can communicate with nebulae up to 950 million light-years' distance; but beyond

that communication is impossible. Consider a nebula distant 950 million light-years; 950 million years hence our message will reach the spot where it now is. But the nebulae are receding at high speed, and by that time the nebula will be 620 million light-years farther away; so the message must chase on after it. However, after 1900 million years our message will at last overtake the nebula. Now for the return journey. This time you must consider that we are receding from the nebula; and there is the same trouble that when the message arrives at our last address, we shall have receded to a still greater distance. For the return message the initial distance is 1900 million light-years instead of 950 million; and, since the speed of recession increases with the distance, the chase is still harder. Actually, the message scarcely gains on us at all. It is like a runner on an expanding track, with the winning-post receding just about as fast as he can run. For a nebula more remote than 950 million light-years, the return message is beaten in the race and never reaches us.

"The faintest nebulae detectable with the 100-inch reflector are about 500 million light-years away. With the 200-inch, now being constructed, we may expect to reach about double the distance. There is, therefore, a good prospect that the 200-inch will show us 'galaxies with which it is impossible to communicate.'" (*Occasional Notes,* Number 3, issued by the Royal Astronomical Society, London, England.)

Correction.—Our attention has been called to the fact that the large meteor in Texas reported on page 329 of the preceding issue in all probability fell on May 2 instead of on May 1, as stated. At any rate a conspicuous meteor was observed in the same vicinity on May 2, and it is unlikely that brilliant meteors should follow the same course at about the same hour on two successive days. This note may tend to remove confusion in the minds of those who read the account and also observed the meteor.

Book Review

Exploring the Heavens, by Clyde Fisher. (x + 223 pages. 48 illustrations from photographs. Thomas Y. Crowell Company, New York City. $2.50.)

"Exploring the Heavens" is Dr. Clyde Fisher's first book on the heavens. It is a simply written work, divided into seventeen chapters, and is intended for those who wish to acquire a background before pursuing further the facts, theories, and hypotheses pertaining to astronomy. Its conversational literary style and its excellent illustrations give the reader a rich flavoring of "the most ancient and noblest of the physical sciences."

Dr. Fisher introduces his book by giving a survey of the solar system. The physical characteristics of the terrestrial planets are presented, including a discussion of the theory of possible life on Mars.

The next two topics center around discussions of the characteristics of sun and moon. The author stresses particularly the importance of sun-spots and their correlation to certain physical phenomena. Impressive are the treatments of the many superstitions connected with the moon, and our satellite's importance to the welfare of mankind.

Dr. Fisher is well qualified to speak upon solar and lunar eclipses, having been a member of several eclipse expeditions. The author's personal experiences

are related in witnessing total eclipses of sun and moon along with satisfactory explanation of the causes of these solar and lunar phenomena.

An excellent illustration of the earth at different seasons of the year is included in the fifth chapter on seasons, and it together with a brief account of comets precedes the division devoted to meteors and meteorites.

Next, the origin of the solar system is considered. Difficulties with Laplace's Nebular Theory have turned astronomers to considering Chamberlin and Moulton's Planetesimal Theory. A recent modification of the latter by Jeffreys and Jeans has been called the Tidal Theory, but even these two explanations are considered too hypothetical by many astronomers and at present there is no universally accepted explanation of the origin of the solar system.

All the general characteristics of stars are concisely reviewed and the two types of nebulae now known to astronomers are also mentioned. The reader is certain to be impressed by the unimaginable size of such giant stars as Antares, Betelgeuse, and Mira.

The main spring, summer, autumn, and winter constellations visible in the latitude of New York City are described in the next four sections. Adequate charts are included and these together with charts in the end-leaves make it possible readily to learn or review the northern constellations.

Chapter fourteen consists of an exposition of the astronomer's instruments and tools. Although the telescope is his primary aid, the spectroscope undoubtedly has contributed more to the science of astronomy than any other instrument.

Those who have never witnessed an aurora should be particularly impressed by Dr. Fisher's descriptions of the aurora borealis, and quotations from prominent adventure writers. Although the causes of the aurora are yet unknown, the work of the research scientist is slowly revealing their mysterious nature.

Dr. Fisher, having been made Curator of Astronomy at the American Museum of Natural History, is well qualified to present some of the questions involving Einstein's Theory of Relativity. He assures the reader he cannot tell him what the Theory is, but he does shed some light concerning what it is *about*. However, regretfully for those who are anxious to learn more about it, the author does not go deep into the subject, because it is essentially a mathematical theory and cannot be understood without mathematics.

The seventeenth and concluding chapter of his book Dr. Fisher devotes to a description of the Hayden Planetarium of which he is head. An account of the Copernican planetarium and of the Zeiss projection instrument, both in the planetarium building, is especially impressive and much credit is given Dr. Walter Bauersfeld, the inventor of the projection instrument: "without doubt the greatest invention ever devised by man as a visual aid in teaching, in any field in the entire history of education."

While "Exploring the Heavens" can add nothing to an astronomer's scientific knowledge, it certainly is worth his reading if only to gain the descriptions of the personal experiences of Dr. Fisher. Although it is accurate and authoritative, the book avoids complicated mathematical and technical data, leaving the layman or student free to form his own wonderful picture of the heavens.

David L. Jones.

Nashville, Tennessee.

POPULAR ASTRONOMY

CONTENTS

AUGUST-SEPTEMBER, 1939

THE FIRST OF THE SCIENCES, Arthur H. Compton 349

NOTE ON A SUPPOSED EARLIER MAXIMUM OF NOVA T CORONAE 1866, Dean B. McLaughlin 353

THE NEW OBSERVATORY AT THE UNIVERSITY OF OKLAHOMA, J. O. Hassler 355

REPORT ON ASTRONOMY, Bart J. Bok 356

MEETING OF SECTION D (ASTRONOMY), OF THE A.A.A.S. AT MILWAUKEE, Harlan T. Stetson 372

THE EFFECT OF LUNAR ECLIPSES ON THE MOON, Walter H. Haas 373

Planet Notes for September and October, 1939 376

Asteroid Notes 378

Occultation Predictions 379

Meteors and Meteorites 380

Meteor notes from the American Meteor Society,—Contributions of the Society for Research on Meteorites: Three new siderites from Kentucky: Campbellsville, Clark County, and Providence; Some properties of the Beenham, New Mexico, aërolite; Fused meteoritic iron: second paper; The Lund, Sweden, aërolite of 1939 April 5.

Variable Stars 390

Variable star notes from the American Association of Variable Star Observers.

Comet Notes 393

Comet 1939 *f*,—Comet Kopff,—Comet Pons-Winnecke,—Comet 1939 *d*,—Comet Borelly,—Comets Wolf and Tuttle.

Notes from Amateurs 395

Ragnarok,—National Convention of Amateur Astronomers,—The New Haven Amateur Astronomical Society,—Amateur Astronomical Society of Los Angeles,—The seventh year of the Rhode Island Skyscrapers.

Communications and Comments 399

Light and quantum effects.

General Notes 402

Personal notices,—American Astronomical Society Meeting,—Cosmic distances,—Correction.

Book Review 404

Exploring the Heavens.

The principal articles of this magazine, beginning with Volume **15** (1907), are listed in the International Index To Periodicals.

49
53
55
56
72
73
76
78
79
80
90
93
95
99
02
04